Green Infrastructure Planning for Improved Stormwater Management in Central New York

Technical Report

Central New York Regional Planning & Development Board
January 2012

Funding for this report was provided by the New York State Department of Environmental Conservation through funds received from the U.S. Environmental Protection Agency under Chapter 604(b) of the U.S. Clean Water Act. Funding was made available through the 2010 American Recovery and Reinvestment Act (ARRA).

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Introduction

The Central New York Green Infrastructure and Stormwater Management Planning Project was conducted by the CNY Regional Planning & Development Board (CNY RPDB) with funding provided through an American Recovery and Reinvestment Act planning grant administered by NYS Department of Environmental Conservation (NYSDEC). Under Section 604(b) of the Federal Clean Water Act, NYSDEC is authorized to award funds to regional and interstate planning organizations necessary to develop water quality planning projects.

The following four project objectives are specified in the project work scope:

(1) Conduct discussions with local municipal partners to identify whole communities or sewersheds within the Syracuse Urbanized Area (SUA) where the volume and quality of stormwater runoff is contributing to water quality issues and repeated flooding and drainage concerns.

(2) Compile existing maps, data and information as the basis for developing a Geographic Information Systems (GIS)-based inventory of current stormwater control practices, known areas of high erosion potential, high pollutant loading, frequent flooding and water quality issues.

(3) Conduct an analysis of local conditions and characteristics to determine potential sites capable of supporting green infrastructure and/or other new or retrofit stormwater control practices.

(4) Evaluate state-approved green infrastructure practices to address peak flow attenuation and stormwater quality relative to local conditions and needs as the basis for developing a database of potential green infrastructure solutions to existing local water quality and quantity issues.

CNY RPDB worked with municipal stakeholders and partner agencies to accomplish the project objectives outlined above. The project is for planning purposes only. Municipalities identified in this report are not committed to implementing any of the specific projects detailed in this report. However, municipalities are encouraged to further consider and evaluate the options presented herein and make independent judgments on their appropriateness for the problems and opportunities identified. Analysis by a professional engineer must also be completed to determine whether the practices suggested will adequately address the water quality or volume control problems that may be present.

Process

The above objectives were achieved through the following tasks:

1. CNY RPDB held an initial stakeholder meeting to provide an overview of the project and to request and explain supporting informational and GIS data needs to representatives from interested stakeholders in the Syracuse Urbanized Area (SUA). Following the meeting, CNY RPDB requested meetings with individual owners and operators of Municipal Separate Storm Sewer Systems (MS4s) in the SUA.

2. CNY RPDB held follow-up meetings with 23 MS4s to identify site-specific and community-wide water quality and quantity concerns that might be addressed by green infrastructure as the basis for further study through this program. Efforts were made to collect storm sewershed and stormwater system maps, post-construction stormwater management practice inventories and existing drainage studies, where applicable.

3. CNY RPDB located all identified sites in GIS using tax parcel data where possible and/or general spatial data where appropriate. Storm sewershed mapping, system mapping, and inventories of post-construction stormwater management practices provided by the municipalities were incorporated into the existing regional stormwater GIS database.

4. General site characteristics (i.e., soil series and Hydrologic Soil Groups present at each site, existing water resources, wetlands, floodplains, and areas of steep slopes) were assembled, and relevant design points were located using outfall mapping and other data and information provided by the municipalities. The drainage area to each design point was delineated in GIS using Digital Elevation Mapping, existing sewershed mapping, and descriptions provided by the municipalities. Estimation of runoff volumes and analysis of phosphorus and Total Suspended Solids loads were completed for the drainage subcatchments affecting each of the sites on both a cumulative and per-acre basis. Soil types and impervious area were assessed in drainage areas to demonstrate sources of drainage problems.

5. CNY RPDB conducted a second round of follow-up meetings with 17 of the 23 MS4s to discuss the results of the GIS analysis and initial findings. Current site conditions, factors contributing to identified problems, and options for possible solutions for each of the sites were further discussed. As a result, CNY RPDB narrowed down the universe of potential sites to a list of "Level 2" sites where implementation of mitigation practices appeared potentially feasible and worthy of more detailed investigation.

6. CNY RPDB conducted a series of site visits based on municipal interest in pursuing feasible projects. Additional data was collected regarding access, drainage patterns, utilities and other potential use conflicts, and existing structural improvements at the sites. This information was incorporated into the GIS database. Appropriate practices were determined for each site based on drainage area size; site conditions including land use, soil type, and topography or landscape position; and retrofit goal (e.g. runoff reduction, peak flow control, water quality improvement, demonstration project, etc.). This information was added to the SUA database by cross-referencing the suggested practices to specific site locations.

7. CNYRPDB sent letters to the participating municipalities documenting findings relative to the sites noted above. The letters identified applicable NYSDEC-approved stormwater control and green infrastructure practices to address problems or opportunities. The letters also included an accounting of additional information necessary to further refine whether the practices could be utilized, and where the practices might be located. The letters requested additional follow-

up information and site visits from municipalities interested in pursuing concept development for identified practices.

8. CNYRPDB conducted a suitability analysis in GIS to further evaluate and display the factors affecting the feasibility and site limitations or advantages relative to using specific practices at specific sites. A matrix was created rating the suitability of 18 possible practices for a total of six different criteria. The various criteria were then weighted in accordance with their importance, producing a raster output that was displayed for the entire Syracuse Urbanized Area. For more information on the suitability analysis, see pages 13-15.

9. CNYRPDB met for a third time with six municipalities to develop preliminary feasibility studies and conceptual sketches for proposed practices in ten sites ("Level 3"). The meetings included site visits to verify drainage areas and/or structures, identify limitations such as space, access, utilities, etc., and denote other relevant field conditions. This information was used along with aerial photography and other mapping received from municipal contacts to develop concept sketches of the projects being conceived. The sketches detailed locations and site features relative to proposed green infrastructure and stormwater management practices.

Deliverables

The tasks summarized above led to the completion of the final deliverables:

- Contact list of stakeholders and regional partners
- Update to the Syracuse Urbanized Area GIS database, including boundary map and list of municipalities, as well as site locations and coordinates of problem and opportunity areas having documented water quality/quantity, erosion and/or drainage issues
- Information library providing detailed information about each of the sites and identified issues of concern
- Results of the GIS analysis displaying drainage area runoff volumes and pollutant loadings
- Summary report of observations and information concerning factors contributing to water quality and quantity issues in major watersheds throughout the Syracuse Urbanized Area
- A GIS map presenting a subset of the originally identified sites where potential stormwater control projects are under consideration, cross-referenced to a database denoting specific possible practices (see Appendix A)
- List and description of potentially appropriate and targeted stormwater control practices linked to locations (see Appendix B)
- Detailed letters summarizing observations and preliminarily assessing possible practices

- GIS suitability analyses evaluating appropriateness or feasibility of practices given existing site characteristics, based on guidance from the NYS Stormwater Management Design Manual
- Descriptions of potential targeted site-specific stormwater control practice upgrades or new installations including green infrastructure controls (see pages 15-26 of this report)
- Concept sketches indicating general design schemes for potential practices (see Appendix C)
- Documentation of all meetings, including agendas, sign-in sheets, and meeting notes

Watershed impacts

The factors contributing to water quality and quantity concerns in watersheds throughout the Syracuse Urbanized Area were investigated as an initial step in the project. The following observations were derived through Geographic Information Systems (GIS) analysis of overall watershed characteristics, such as slope, predominant land use and land cover, and location of wetlands and floodplains. A more detailed analysis was also completed for areas of concern identified by participating municipalities. This analysis included the use of the Simple Method as described by US EPA (1993) to estimate impervious area, coverage of hydrologic soil groups, runoff volumes and loading of phosphorus and Total Suspended Solids (using concentration data developed by the University of Alabama and Center for Watershed Protection, 2005) within the identified subwatersheds. The watershed impact descriptions also include information obtained during interviews and discussions with municipal representatives and other documented background information concerning watershed conditions. In general, watersheds are grouped by common characteristics among the sites studied; smaller divisions were used in the center of the urbanized area because of the greater concentrations of sites and diversity of water quality and quantity issues.

Ley Creek and Beartrap Creek Watershed

The watershed as a whole is very heavily developed and contains a mix of residential, commercial, and industrial uses. The gradient of Ley Creek and its tributaries is minimal throughout the watershed, and elevation change as the main stem approaches Onondaga Lake is negligible, leading to significant flooding issues. Flooding is exacerbated by the fact that channelization of most of the length of the creek and tributaries has occurred, eliminating natural floodplain areas. Large quantities of impervious area throughout the watershed contribute to the total runoff volume. The use of green infrastructure practices to retrofit impervious areas has been identified as one way to reduce the impacts. However, in many cases, soil capacity to infiltrate stormwater is minimal due to poor drainage, and conveyance improvements would lead to minimum reduction of flooding due to the naturally low slope of the channels within the north and south branches of Ley Creek and other tributaries, including Sanders Creek and Beartrap Creek.

The high concentration of stormwater hotspots is responsible for introducing a host of pollutants to these streams. Use of the Simple Method model has shown that many of the drainage areas contributing to identified sites within the watershed exhibit high phosphorus and Total Suspended Solids loads on a per acre basis due to residential and commercial land use, respectively. Much of the development in the watershed is old and lacks stormwater runoff controls. Most of the developments do not have easements to allow access to the existing drainage systems, many of which are insufficient. Retrofit opportunities are limited due to the high preponderance of private property, but as redevelopment proposals occur, local planning boards should seize opportunities to incorporate green infrastructure and stormwater retrofits.

Ninemile Creek and Geddes Brook Watershed

Erosion and sediment input is one of the most significant problems in the Ninemile Creek watershed. This is of concern particularly due to the creek's designation as a trout stream and its importance for recreational fishing. Development of steep hillsides in the watershed has led to formation of gullies and ravines within areas of open drainage. Channelization of streams and alteration of natural drainage patterns has, in some areas, led to flooding and erosion. Soils throughout many of the problem areas identified in this project are of good quality to allow infiltration. The potential to realize significant benefits through green infrastructure is significant in this watershed.

Most of the upper watershed of the main stem of Ninemile Creek is rural. A key focus for Planning Boards should be to ensure that new development is protective of natural resources that play important roles in hydrology of the watershed. Several new, single-family residential developments characterized by low densities and large lot sizes are occurring on former agricultural land in this part of the watershed. The potential exists for high phosphorus and nitrogen loads to be generated by these developments.

Issues that have been identified within the highly developed Geddes Brook portion of the Ninemile Creek watershed include (1) steep slopes with erodible soils, leading to introduction of large quantities of sediment to drainage systems, (2) use of closed conveyances (particularly in old neighborhoods and highly urbanized areas) with inadequate capacity to transport runoff, causing upstream bottlenecks that lead to localized flooding, and (3) locally high phosphorus loading from dense residential development within identified problem sewersheds, as modeled by the Simple Method. There are few easements and public lands to install retrofits that would correct these problems, but any opportunities that do exist should be utilized to the fullest extent possible. Erosion control on steep slopes should also be a high priority in the area.

Onondaga Creek Watershed

The Onondaga Creek watershed contains hilly topography. Significant development (particularly residential) has occurred at both high and low elevations within the watershed. Localized flooding has resulted in areas that receive flow from the steeper, developed parts of the watershed. Portions of the watershed that contribute to problem areas contain some soils with good infiltration capacity; however, many of these areas occur on steep slopes. A significant proportion of the watershed is rural, and a key focus for Planning Boards should be to ensure that new development is protective of natural resources that play important roles in the hydrology of the watershed. New developments occurring in the upper (southern) parts of the watershed are generally low-density residential subdivisions with very large lots, often on former agricultural land. Potential high phosphorus and nitrogen loading from these developments is a concern.

The watershed is also impacted by the introduction of sediment from geologic phenomena known as mudboils, which occur in the upper (southern) part of the watershed. The mudboils introduce heavy loads of sediment to the stream that persist throughout its length, to the Inner Harbor of the City of Syracuse where Onondaga Creek meets Onondaga Lake. Combined sewer overflows in the City of Syracuse have historically led to flooding as well as the introduction of pathogens, nitrogen and phosphorus compounds, and floatables to Onondaga Creek. Onondaga County and the City of Syracuse are working with regulatory agencies to remedy these problems.

Bloody Brook and Sawmill Creek Watersheds and Direct Drainage to north side of Onondaga Lake

Areas along the north shore of Onondaga Lake are contained within Onondaga Lake Park, and are bordered by heavy residential and commercial development. Problems associated with this development include discharge of yard and foundation drains to Onondaga Lake, channelization and alteration of stream corridors to accommodate development, and inadequacy of existing stormwater management practices to fully address runoff volumes. Some of the subwatersheds modeled using the Simple Method reflect extremely high concentrations of Total Suspended Solids (TSS), attributed to commercial land use or high phosphorus levels resulting from residential uses. The use of green infrastructure or retrofits of existing stormwater management practices could help to mitigate these problems. Aside from several opportunities on public land presented by Onondaga Lake Park, many of the possible green infrastructure opportunities in the area would likely require cooperation with private commercial land owners.

The watersheds of Sawmill Creek and Bloody Brook contain dense commercial and residential development. Very high loading rates of both phosphorus and TSS are indicated by the Simple Method in some of the commercial areas studied. While soil characteristics are variable in these basins, the majority appear to be fair to poor for infiltration. Green infrastructure opportunities may be limited and should be utilized to maximum benefit where they are available.

Harbor Brook Watershed

The watershed of Harbor Brook has been documented to contain drainage problems caused by the development of hillsides and steep slopes. Intense residential and commercial development is present in the lower portion of the Harbor Brook watershed, producing high phosphorus and TSS loads in some areas. Much of the drainage infrastructure in these areas is very old and in some cases, in need of retrofit due to capacity limitations and/or poor hydraulics. Unfortunately, few easements or public open spaces are available in these heavily urbanized areas. The introduction of impervious surface increases runoff from these areas, causing overload of existing conveyance systems and streams. Many of the existing conveyances consist of closed systems originating from mid-aged to old developments, some of which are associated with combined sewers. Parts of the watershed also contain steep slopes on which erosion is occurring. In some cases, sediment from these slopes clogs closed drainage systems, creating localized flooding.

Impacts resulting from the erosion and sedimentation problems discussed above include the introduction of sediment, nutrients, and pathogens to Harbor Brook and its tributaries. Much of the watershed contains adequate soils to support infiltration, which may provide some mitigation of the problem, but this potential may be limited by steep slopes throughout the area. Combined sewer overflows in the City of Syracuse have historically led to flooding as well as the introduction of pathogens, nitrogen and phosphorus compounds, and floatables to Harbor Brook. Additionally, areas exist where roof downspout and foundation drainage is cross-connected to the sanitary sewer system, causing sanitary sewer overflows that discharge the same types of pollutants. Onondaga County and the City of Syracuse are working with regulatory agencies to remedy these problems.

Unnamed tributaries on south side of Onondaga Lake

Much of the watershed of the south shore of Onondaga Lake and its small tributaries is heavily developed with residential, commercial, and industrial land uses. Several key sewersheds in this area exhibit fairly high phosphorus and Total Suspended Solids loads on a per acre basis as indicated by land use-based modeling with the Simple Method. A lack of sufficient elevation change, insufficient capacity of drainage systems, and interruption of drainage pathways by railroad corridors have combined to produce significant drainage problems in the area. Wetlands exist near the south shore of the lake, particularly along Route 690, but are impaired by industrial development. Restoration of wetland functions may have the potential to improve stormwater management in the area.

Oneida River/ Lake Watersheds (includes Mud, Volmer, Big Bay, Little Bay, Caughdenoy Creeks)

These watersheds are largely rural and undeveloped. The portion of these watersheds within the Syracuse Urbanized Area contains very flat topography. Many of the conveyance systems in existence (both open and closed) contain insufficient capacity and/or storage to carry stormwater out of developed areas. In some areas, open drainage systems were not constructed to optimize flow, and lack of maintenance has resulted in buildup of sediment and debris. The manipulation of water levels in the Oneida River and Oneida Lake also creates periodic backwater effects that negate the capacity of existing drainage conveyances. As residential development within the watershed increases, these impacts are likely to worsen. Simple Method modeling shows that phosphorus loading levels may be elevated in portions of the watershed where urbanization is taking place. Although large areas of clay soils are present in many of the problem areas, pockets of soil also exist that are of good quality to promote infiltration. These soils should be preserved and their use in infiltrating runoff should be maximized.

Seneca and Oswego River Watersheds

The primary issues identified in the urbanized portion of the Seneca River watershed (and the short stretch of the Oswego River immediately downstream) include erosion caused by conveyance structures with insufficient capacity and/or poor hydraulics, leading to sediment loading in the river, as well as flooding in areas where inadequate culvert sizes have been used. Hydraulic problems range from both open and closed conveyances being overwhelmed by the volume of flow they must carry to insufficient grade, resulting in major backups within closed systems.

Simple Method modeling has shown several of the problem drainage areas in the Seneca River watershed to exhibit very high phosphorus loading on a per acre basis as a result of dense residential development. Introduction of pathogens resulting from sanitary sewer overflows (due to introduction of stormwater to the sanitary system) has also been identified as a significant impact. The opportunity exists to help address sewer separation problems using green infrastructure practices within greenspace areas that are already incorporated into existing developments. The need for retrofit of an existing stormwater pond to prevent nutrient loading to the Seneca River has also been documented.

Butternut, Limestone and Chittenango Creek Watersheds

Flow within all three of these watersheds is influenced by topography and geologic features. These creeks begin as steep-graded streams in rural upper parts of the watershed and abruptly level out as they enter the lake plain. At approximately the same point, they enter developed areas. Severe overbank flooding is the result. Soil and Water Conservation District programs in Madison and Onondaga Counties have been developed to carefully remove blockages in the stream corridor that have been creating erosion and overtopping of banks. Drainage systems within the lake plain are impeded by both the lack of gradient and poor maintenance. The area is further impacted by the presence of karst topographic features and the occurrence of bedrock near the surface in some of the developed areas, particularly in the upslope parts of the watershed. Bedrock impedes drainage in some parts of the watershed, while karst geology produces unpredictable drainage patterns and emergence of springs.

Modeling using the Simple Method indicates that the intense residential development in the drainage areas studied leads to high phosphorus loading per unit area. Additional problems observed in different parts of the Butternut and Limestone Creek watersheds include influx of stormwater to the sanitary sewer system (leading to overflows), and hydraulic restrictions in closed conveyance systems that lead to backups and localized flooding. It has also been noted that improper construction of stormwater management ponds may be allowing sediment to escape from construction sites into bodies of water within the watershed. While green infrastructure solutions may be feasible in some areas, close study of the influence of geology is needed prior to design and implementation.

Suitability Analysis

Background and Procedure

The suitability analysis was used to validate initial observations concerning the viability of 18 specific stormwater practices, and to graphically illustrate the factors affecting the decision to further consider or disregard particular stormwater practices in a given area. Suitability analysis was also used to identify design sites where geographic factors were less than optimal for implementing a particular practice. In these cases, more detailed site analysis was considered necessary to determine whether a site was likely to support a particular type of practice. The geographic factors taken into consideration were hydrologic soil group, slope, land use, proximity to roads, and wetland and floodplain presence. Within these individual factors, ranges of suitability were established and ranked for each particular practice. Because these factors vary spatially, the Syracuse Urbanized Area (SUA) was divided into a grid, allowing each cell, or unit of geographic space, to be analyzed. For example, the slope of a particular cell was ranked according to where it fell within the range of acceptable slope values for the particular practice to function.

Once acceptable criteria for each factor were established and ranked, they were given a suitability value of 0 to 5, with 0 representing the least suitable, and 5 representing the most suitable. A new data layer was created for each factor based on the rankings in which each cell was assigned a suitability value. For example, slope data is provided as a percentage range (e.g., 0 to 2 percent, 2 to 5 percent, etc.). In the suitability analysis, a ranking of 0 to 5 was established for each of these slope ranges, creating a new data layer.

The ranked and weighted layers were then added together to obtain a numerical value for the suitability of the stormwater practice for each cell in the SUA grid. These numerical values ranged from zero to thirty, with areas receiving a ranking of zero being least suitable, and areas achieving a rank of thirty being most suitable. The geographic factors affecting suitability were mapped and assessed individually and collectively in order to display the overall suitability of the practice to the site. Through this process, it was possible to identify which factors had the greatest influence over the feasibility of the practice in question.

Suitability Factors

The following section contains a brief discussion of the geographic factors that were ranked and weighted for each practice.

<u>Hydrologic Soil Group</u>

The type of soil in the area where a stormwater management or green infrastructure practice is to be located strongly influences its viability. Hydrologic soil group indicates the infiltration rate present in a given soil series. The four hydrologic soil groups that have been designated by USDA Natural Resources Conservation Service are identified as: A (very permeable sandy or sandy loam soils); B (loams or soils with high percentages of silt); C (loams with high percentages of both sand and clay); and D (nearly impermeable clays or clay loams). Rain gardens, pervious pavement, infiltration basins, vegetated swales and filter strips generally require A or B soils and obtain high suitability ratings of 3, 4 or 5, while C and D soils receive low suitability ratings of 0, 1 or 2 for these practices. In contrast, certain practices such as wet ponds and wetlands are better suited to C and D soils, so the rankings are reversed for soils relative to those practices.

Hydrologic soil group was weighted as the most important factor (0.3 out of 1) as it impacts the rate of infiltration. For most green infrastructure practices, a certain rate of infiltration is necessary in order for them to function correctly.

Land use

The specified land use or zoning classification of the area in which a practice is to be located significantly affects its suitability. There are two aspects of land use that are taken into account: the layout pattern of a given type of development; and, the perception of the practice by the public in the context of the land use that is present. For example, some practices such as stormwater wetlands, infiltration trenches, and sand filters may be undesirable in a residential area because residents dislike their appearance or believe they encourage the presence of pests such as mosquitoes. Residential areas receive low suitability ratings (0 to 2) for these practices. Some practices appear to be practical and relatively easy to implement in certain settings. For example, pervious pavement and bioretention areas are well suited to commercial development because of the prevalence of parking lots. In such cases, the accommodating land use receives high suitability ratings (3 to 5) for those practices.

Land use was weighted as being very important (0.25 out of 1) because it is often the deciding factor in selecting one possible option over another.

Slope

Slope is a key consideration for most types of stormwater management and green infrastructure practices. Many practices cannot be built in areas where significant slopes are present, while other practices that include internal drainage (underdrains and/or surface outlet structures) typically depend on a certain degree of elevation drop, or “hydraulic head”, to function. Practices such as bioretention, filter strips, dry swales, wet ponds, wetlands, surface sand filters, and infiltration basins can be correctly constructed and obtain optimal function in areas where slopes are in the gentle to moderate range (1 to 5, or in some cases, 2 to 10 percent). Generally, no practices can be properly designed or constructed on slopes that exceed 15 percent (such slopes have received a “0” rating for suitability).

Slope was determined to be an important variable in evaluating practice suitability (0.2 out of 1).

Proximity to roads

The distance of a practice from an existing public roadway affects ease of access for inspection and maintenance. Generally, closeness to a roadway improves the ease with which a stormwater or green infrastructure feature can be maintained. This is especially true when maintenance requires the use of heavy equipment on-site (i.e., stormwater ponds, wetlands, swales, and bioretention areas). At the other end of the spectrum are smaller scale practices that do not require specialized maintenance equipment or that can be maintained by individual property owners (i.e., rain gardens, stormwater planters, and rain barrels). Because the relative importance of roadway distance varies with the size and complexity of the implemented practice, and because it can be overcome through proper planning, proximity to roads was considered one of the less important factors in determining suitability (0.1 out of 1). Easy access is advantageous but not mandatory.

Presence of/proximity to wetlands

In order to perform as intended, many green infrastructure and stormwater management practices should not be located in a wetland, or in areas of hydric soils (where seasonal or regular saturation of inundation occurs). This is particularly true of practices that rely on infiltration to reduce runoff and/or improve water quality (e.g., pervious pavement, bioretention, vegetated swales, and rain gardens); this means that wetland areas receive a “0” for suitability for these practices. Separation from the groundwater table is also critical in large-scale practices such as most types of wet ponds, while practices such as stormwater wetlands, wet swales and pocket ponds are dependent on contact with the water table. As a result, wetland areas receive higher suitability rankings for such practices.

All construction work in wetlands requires federal and/or state permits, which may preclude construction of any practice unless it enhances existing wetland resources. Because this factor is identified independently from the suitability analysis, its presence in the analysis (while necessary) is not as important as other factors (0.1 out of 1). In this context, it is the function of the practice under wetland conditions that is evaluated; this aspect may be partially accounted for by hydrologic soil group.

Floodplains

It is preferable to avoid locating most practices in floodplain areas if at all possible. This is more important for some practices (pervious pavement, swales, bioretention, stormwater wetlands, wet ponds, infiltration basins) than for others (e.g. rain gardens, filter strips). Most practices have moderate suitability ratings in the 1 to 4 range for location in a floodplain.

This factor is of lower importance because most practices are intended to treat a much smaller volume than would occur in a 100-year storm, upon which the floodplain designations are based. Thus, floodplain presence or absence is not particularly meaningful for many of the available options (0.05 out of 1).

Design concept development for Level 3 sites

The following sites were given additional consideration through meetings and field visits with the municipalities. Concept sketches illustrating the practices and options discussed are included in Appendix C. These drawings are provided to demonstrate the concepts developed for the various sites.

Locations of existing drainage and utility features and infrastructure are approximate and are *not intended for use in engineering design*. The proposed improvements shown are conceptual in nature and are *not intended for construction*. The exact size, location, or types of practices appropriate to the site may be subject to change upon more detailed engineering-level investigation.

Town of Clay, Bayberry Planned Development Neighborhood (Site 15)

The Bayberry Community Planned Development has experienced numerous problems related to insufficient capacity in existing storm sewers and cross-connection of drainage structures to the sanitary sewer system. Flooding and backup of sewage into homes have occurred during a number of major storm events. The sewage treatment facility on Wetzel Road is overloaded during these times and discharges untreated sewage directly to the Seneca River. The storm sewer system collects flow through subsurface structures and ultimately discharges into a small stream that daylights west of Cherry Tree Circle, north of Orangewood Drive. This drainageway continues north through a wetland area and into the Seneca River immediately south of the sewage treatment plant.

The Town is interested in exploring the option of using green infrastructure to reduce the quantity of flow entering primary storm sewer conveyances, and by doing so, alleviate system backups and the threat of property damage. Several areas were identified near the primary stormwater drainage system that could be considered for green infrastructure retrofits. The overall concept employed involves the reduction of stormwater volume entering the storm drainage system. This will assist in allowing the current MS4 to accommodate the additional flow that would result from disconnection of downspouts and foundation drains from the sanitary sewer system.

In the common area south of Blackberry Road opposite Cherry Tree Circle, a large box culvert approximately 4 to 5 feet in width exists beneath Blackberry Circle. No flow is present at the culvert during dry weather. A low-lying area receiving flow from Blackberry Road is present near the mouth of the culvert, west of an existing footpath. The area extends about halfway south along the back semicircle of Cardinal Path; this is one possible area for bioretention. Sewer mapping obtained from the Town of Clay shows a storm sewer line beginning with a catchbasin on Cardinal Path and extending northeast toward the culvert beneath Blackberry Road. If feasible, the bioretention area would receive flow from this conveyance up to the water quality storm event and then bypass the remainder to the existing line using a flow splitter. At least one structure would need to be installed to accomplish this, and/or the bypass pipe would need to be daylighted at the proposed bioretention area; inverts would need to be known to determine if the hydraulics would be sufficient. Flow would enter the bioretention area through a vegetated swale; a level spreader would need to be added at the end of the daylighted culvert to disperse flow.

The basketball court between Quail and Dove Paths in the center of the common area contains a small drain in the center, less than a foot in diameter. It is not known whether the drain is connected to the sanitary or storm sewer system, but it is covered with sediment and likely does not function properly. The surface on the basketball court could be replaced with porous asphalt. It may be possible to pitch the surface to the outside edge and disperse the runoff into the surrounding turf (instead of to the center) if the underlying soils exhibit poor drainage. Although this project would not help to address the overall flooding concerns, it would provide an excellent example of the potential that green infrastructure holds in locally reducing runoff.

Sanitary sewers do not appear to conflict with the potential practice locations described above. No other utilities have been identified as intersecting the common area, but additional verification of the locations of water lines and electric/telecommunications cables is recommended. Aboveground wires were not observed in this portion of the neighborhood, so it is assumed that these cables are installed below the surface.

A common greenspace area exists north of Blackberry Road and east and south of Cherry Tree Circle. Immediately north (downstream) of the dry culvert beneath Blackberry Road, a large basin exists, which collects flow from Blackberry Road as well as Cherry Tree Circle and Damson Lane. This large low-lying area continues through the space between Berrywood Lane and Damson Lane, extending west to Cherry Tree Circle. The area is drained by a 12-inch culvert beneath Cherry Tree Circle, which flows west to the area south of Orangewood Drive. It is possible that a bioretention area could be installed in the low-lying area. The practice would most likely receive drainage from the series of four structures on Damson and Elderberry Lanes (one advantage is the location of the easement from Damson Lane). The scheme would be similar to that used for the Cardinal Path practice noted earlier; flow would be split by daylighting the outlet pipe to a bioretention area through a vegetated swale with dispersion by a level spreader. However, in this case a stormwater catchbasin already is present in a location where it could be used for an overflow structure; the rim of the structure would need to be raised and the underdrain connected above the invert of the outlet pipe. A sanitary sewer line bisects the low-lying area, and this conflict would need to be resolved (in particular, care must be taken not to pool water above the existing manhole). The presence of several large trees might also restrict the space available for the practice.

An opportunity also exists to capture drainage from the vicinity of Huckleberry and Ilex Lanes and divert it to an open swale system south of Forester and Glenburn Roads. The swale would be positioned within the existing channelized area and would intercept flow from this part of the drainage system using a flow splitter. High flows would continue to enter the existing system. A wide easement extends northwest of Huckleberry Lane, providing ample space to add the conveyance line. A small settling basin could be installed at the upstream end of the swale using a permanent check dam, in order to provide pretreatment. An overflow structure and overflow pipe would need to be installed, and an underdrain would be added to the swale. Inverts would need to be known to determine if the hydraulics would be sufficient.

Nearby, space may also be present to accommodate a practice in another depression south of Berrywood Road and southwest of the cul-de-sac of Forester Road. An easement exists originating from between the two southwest lots of the Forester Road cul-de-sac to provide access. A bioretention area located in this space might be able to handle flow from Forester Road and the east end of Berrywood Road. This would require constructing a new outlet pipe from the existing catchbasin on Forester Road that would daylight through a level spreader to a vegetated swale continuing southwest to the practice. Overflow might be directed to an existing stormwater catchbasin at the south end of the easement, if elevations of the structures offer sufficient hydraulics.

The Foxberry/Gooseberry Lane area contains an easement at the northwest end of the loop. It may be possible to install a new outlet pipe at the existing stormwater catchbasin at the north end of Foxberry Lane. The outlet would be daylighted to a vegetated swale that would disperse flow prior to entry into a bioretention area northwest of the loop. An existing drainage catchbasin present at this location might be used as an overflow structure if its rim can be raised. If the bioretention area cannot be sized to sufficiently treat the entire Gooseberry and Foxberry Lane system (which covers a relatively large drainage area), a flow splitter could be considered instead; it would intercept only the low flows to the bioretention area, with high flows continuing to enter the existing system. Again, it would be necessary to work out the invert elevations to make the system function.

Sufficient space appears to be available to position these practices with enough distance from existing sanitary sewer mains. However, storm drain conveyance structures may intersect the sanitary lines in a few locations, and potential conflicts of location may need to be resolved in these areas.

The above areas discussed are all located within Hydrologic Soil Group C soils. As a result, standard bioretention areas with underdrains at the bottom of 2.5 to 4 foot depth soil medium would be most suitable. However, the option remains to raise the underdrains within the column of the soil medium to allow some infiltration to occur. Close evaluation of the drainage characteristics of the soil is recommended if this approach is used.

Village of East Syracuse, Bagg Street Highway Garage (Site 30)

The parking and staging lot of the Village's highway garage on Bagg Street is subject to poor drainage. Standing water originating from stormwater runoff accumulates, resulting in damage to the pavement, and runoff from roofs and pavement enters stormwater drainage systems without treatment. Runoff from the highway garage is carried south through a drainage ditch along Bagg Street into a larger system of ditches paralleling Route 690, which eventually discharges to the South Branch of Ley Creek.

The option of using a linear sand filter structure was investigated. There is insufficient hydraulic head available to construct a standard underground perimeter sand filter. A shallower modified filtering system could perhaps be designed to improve drainage and water quality. The system could possibly be set up to bisect the parking lot in a west to east direction with a series of inlet grates. The system beneath the inlets could perhaps consist of a layer of sand atop aggregate with an underdrain within, and a concrete or geotextile liner below. The resulting sand filter would constitute a significant deviation from NYSDEC standards, but would nonetheless offer water quality improvements to the discharge from the site. The total drainage area to the sand filter system would be approximately 1 acre, well within the allowed range, but because the depth of the system is shallower than the standard, maintenance frequency would be greater than typical for the practice. Sand would periodically have to be cleaned out and replaced, and regular monitoring would be necessary. If the inlet grate openings could be separated from the main filtering system by a set of baffles, pretreatment would be possible and maintenance frequency might be less.

It was noted during the site visits that because much of the parking lot drains to the west, transferring flow to the east would require working against grade. A drainage swale exists to the west, but is too shallow to receive an underdrain connection from the filter. The elevation of the parking is approximately 410.3 feet. The underdrain of the sand filter, if constructed 1 to 1.5 feet below the surface, might be permitted sufficient elevation drop to be connected to an existing catchbasin immediately across Bagg Street, which has an invert of 407.0 feet with a 12-inch outlet pipe. The hydraulics of the system would require precise engineering-level verification to determine feasibility; the extent and location of the filter system may need to be significantly adjusted. Another challenge to overcome is the existence of the sanitary sewer line running parallel to the west side of Bagg Street at an unknown depth. This could significantly limit the available vertical position of the filter's underdrain, which may be very shallow prior to exiting the filter system.

The alternative of using an infiltration practice was also evaluated. Soils are HSG C, and are believed to contain a clay layer at the top, underlain by sandy soil; to use infiltration, water would need to directly enter the sandy portion. This idea is not considered a good option because it is believed that petroleum and chloride pollutants would be sufficiently high in the parking lot runoff to risk groundwater contamination.

The facility contains several downspouts from the roofs of both buildings. A roof leader on the southeast corner of the larger north building discharges into the parking lot, very close to a grassed area east of the building. This particular downspout could be extended and redirected to flow around the corner of the building to the grassed area. Space is limited by the existence of a sanitary sewer conveyance to the immediate west of Bagg Street. Approximately 30 feet remains between the building and the sewer line to establish a rain garden or bioretention area. A rain garden is more likely to be practical even though the soils at the site are Niagara (HSG C). Although a drainage catchbasin exists at the northeast corner of the property, likely within the Village ROW, the outflow from a bioretention area could probably not be connected to this structure. The surface elevation near the building is presently about 410 feet, and the invert of the catchbasin is 408.22 (less than 1 foot below the likely bottom elevation of the bioretention area, allowing insufficient hydraulic head). Replacement of the structure would be necessary, and the impact on flow to the next structure in the system (invert 406.53) is uncertain. The aforementioned sanitary sewer line also lies between the proposed location and the catchbasin. A rain garden can be used if soils are shown to have a sufficient infiltration capacity. It is estimated that the easternmost 50'x50' area of the roof flows to this corner downspout.

Similarly, the remaining three downspouts (two more on the northern building and one on the southern building) could perhaps be directed to stormwater planters. The possibility of using flow-through planters could be evaluated if the planned filter and underdrain system were installed down the center of the parking lot. If not, the soil profile at the site could be investigated further, as it is thought to consist of clay overlying sand. It may be possible to infiltrate runoff directly into the ground using both the rain garden and/or deeply constructed stormwater planters, since the discharge consists of relatively clean rooftop water. Alternatively, the Village may want to explore the option of connecting downspouts carrying additional drainage from the western portions of the north building's roof to the rain garden discussed earlier. This would necessitate an increase in the rain garden's surface area. Another option would be to direct roof runoff from either or both buildings to cisterns; the stored water could be used for vehicle washing during dry weather.

Village of North Syracuse, Centerville Place/Trolley Barn Lane (Site 63)

To alleviate the problem of repeated standing water in the intersection of Centerville Place and Trolley Barn Lane (even during moderate storm events), the Village plans to replace the currently undersized drainage system that captures runoff from the two streets and adjacent properties. The existing 18" pipes will be upsized to 24" pipes. The drainage system within the development was constructed to carry flow to a detention basin at the intersection of Trolley Barn Lane and South Bay Road. Currently, the flow accumulates in an underground vault near the bend in Trolley Barn Lane. Most flow presently is unable to reach the basin. Overflow from the development enters the subsurface drainage conveyances along South Bay Road and is carried north to a series of wetlands north of Route 481 that feed west into Mud Creek.

The existing detention basin has no outlet, and its inlet is approximately 6 to 8 feet below surrounding grade. If additional flow was introduced to the detention basin, an outlet structure would need to be added to control discharge during storm events. Depending on the outlet configuration, conversion to a wet pond may be possible. It might also be possible to connect the outlet pipe to an existing catchbasin near the northwest corner of Trolley Barn Lane and South Bay Road, which is approximately 8 feet in depth. The pond currently is deepest at the inlet, and the remainder slopes toward the inlet. Significant re-grading and deepening of the pond would likely be necessary to ensure that the water quality volume is contained within the permanent pool (below the inlet elevation). New York State standards call for the side slopes of the pond to be decreased to 1:4 for safety reasons, and for an aquatic bench to be established around the pond perimeter approximately 12 to 18 inches below permanent pool elevation to promote pollutant removal. Addition of a forebay at the inlet would allow settling of sediment. A series of check dams (earthen or gabions) would be used as a spillway containing the forebay.

Engineering analysis of the system is required in order to determine grading, outlet and orifice configuration, and the ability of the South Bay Road structure and system to accept the additional flow. The characteristics of the underlying fill material must also be evaluated; some neighboring areas contain HSG A soils, and the infiltration rate in such soils would be too rapid to allow a permanent pool to form. If this is the case at the location of the existing basin, the pond would require a liner; an infiltration basin might also then be given consideration to determine if it is a more appropriate practice.

The grassed area northwest of the Community Center parking lot receives runoff from the area to the north that is likely part of the water that ponds at the Centerville Place/Trolley Barn Lane intersection. A structure with a bottom about 4 feet below grade, believed to be a dry well, exists in this area. A 4-inch pipe enters from the east; it is not clear whether this is an outlet connecting to the existing drainage system or an underdrain from the Community Center parking lot. Flow from the adjacent parking lots to the west and south accumulates in the grassed area. A bioretention area could be added around the perimeter of the grassed area by lowering the elevation throughout the area, including the space surrounding the catchbasin, which could be used as an overflow structure. Presently, infiltration of stormwater in the area is good. However, by installing bioretention, stormwater detention could be improved to reduce peak flows into the system, and water quality treatment could be enhanced. The necessity and feasibility to connect the structure to the Trolley Barn Lane drainage system would need to be investigated. If the infiltration rate of the dry well is sufficient, such a connection may not be necessary. The bioretention area would function as pretreatment for runoff entering the dry well. The grassed area is proposed to be converted into a pocket park with a gazebo. It is likely that the bioretention area can be located so that it does not conflict with the location of the gazebo. If landscaped properly, the bioretention area can serve as an attractive feature of the park.

Onondaga County, Onondaga Lake Park at NYS Thruway overpass traffic circle (Site 94)

The parking lots and traffic circle located at the northwest end of Onondaga Lake Park regularly experience nuisance flooding and poor drainage in an area immediately adjacent to Onondaga Lake Outlet. Employment of green infrastructure features in this area would offer the opportunity to both address the periodic inundation problem and provide water quality treatment for phosphorus and other pollutants.

Two existing drainage ditches exist immediately parallel to the New York State Thruway, on State property. These ditches drain the north sides of the two adjacent parking lots and are separated by the crossing of Onondaga Lake Parkway (i.e. the access road). To help alleviate the water ponding problem in the area, and to improve water quality treatment, it is proposed that the ditch west of Onondaga Lake Parkway be enlarged and converted to a Type O-1 dry swale. The slope of the existing ditch is less than one percent, but because of a steep drop of about five feet at the west end where the ditch flows into Onondaga Lake outlet, it is likely that sufficient hydraulic head can be provided in the underdrain. A smaller drainage channel also exists around the southern perimeter of the western parking lot and turns north to join the larger ditch. This could also be modified to a narrow dry swale. The channel continues west from the junction, and the swale would terminate where it is interrupted by an access pathway alongside Onondaga Lake Outlet. Flow would enter an overflow structure at this point and be carried to Onondaga Lake Outlet via a culvert beneath the pathway.

The east ditch, along the northern edge of the parking lot, has insufficient grade to be converted to a water quality swale. It is therefore suggested that a simple vegetated swale be used instead; this would likely involve soil restoration and vegetation enhancement. The same approach may be used in the shallow ditch along the east side of this parking lot, which joins with the other ditch in the northeast corner. These swales would discharge to the canal feeder ditch that parallels Onondaga Lake Parkway to the north, but because this area is a State-regulated wetland, an outlet pipe cannot be constructed to discharge into it directly. A shallow overflow weir stabilized by rock riprap at the point where the two swales join would allow the swales to discharge to the canal only during high flow events.

The exact position of the swales on both the east and west parts of the site would be determined by the precise location of a buried fiber optics cable known to exist at the base of the slope upon which the Thruway overpass is constructed. Any excavation needed to widen the existing drainage ditches and/or install soil media as required must occur south of the location of the cable.

Several areas around the parking lots could be converted to sunken vegetated islands with soil restoration and amendment, as well as vegetation enhancement, to promote infiltration. These include the center of the traffic circle located between the two parking lots (currently raised above grade); the small raised island between the traffic circle and the west parking lot; and two open grassed areas to the south of the east parking lot. A shallow grassed depression also currently exists at the southeast corner of the east parking lot and could perhaps be enhanced, although a utility service box is present nearby, indicating a possible buried cable. It is also noted that the traffic circle is bisected by a new waterline. Exact depth and location of the sunken area within the circle would depend upon the depth and location of this utility.

Onondaga County, Onondaga Lake Park Recreation Trail @ Village of Liverpool (Site 95)

Drains from neighboring residential backyards discharge at the bottom of a slope along the East Shore Recreation Trail between Sycamore Street and Birch Street. The flow from these drains causes accumulation of water alongside the trail. Because the wet conditions make it impossible for the County to mow the grass during certain times, grass and weeds are often high and unsightly. It is not known if the water carried by the drains is strictly clean water.

To address the identified problem at the site, a bioretention area may be used to collect drainage from the roof leaders and lawn drains, which circumvent the storm drainage system and flood the shoreline area. Bioretention would offer both drainage and an opportunity for water quality treatment; an underdrain would be essential due to the poor drainage characteristics of the underlying soil. It is suggested that linear bioretention areas be installed within the two wet areas. Because the available catchbasins are shallow, the design would deviate from the original NYS design standards as the underdrains will be at a much shallower depth below grade than typical (1 to 1.5 feet). The depth of the soil medium can continue beyond the underdrains, allowing runoff reduction to occur in addition to the filtering mechanism provided by the underdrains. Utilities need to be carefully avoided; a telecommunications cable parallels the trail at a distance of approximately 50 feet to the north. A gas pipeline is installed very close to the trail on the north side; its exact location has yet to be determined. The use of a coarser/sandier material than typical bioretention soil has been discussed and would provide more pore space to store water. This design would deviate from standards, but would be advantageous given the poor drainage. While some water quality benefit would be compromised and maintenance would need to be conducted more frequently, as a whole it is believed that the practices would be beneficial and could also be utilized as both an aesthetic feature (with attractive landscaping and colorful plants) and an educational demonstration (with signage).

The proposed west bioretention area is opposite the south end of Bass Street. A catchbasin structure already exists within the wet area and conveys flow across the trail to the existing system. Slight excavation around this structure and installation of the soil medium and vegetation between the two utility lines would be all that is necessary to implement this practice.

The proposed east bioretention area is opposite the Bass Street/Balsam Street block in the Village of Liverpool. Construction of this bioretention area would require the installation of a new overflow structure, which would be connected to an existing catchbasin located at the west end of the open drainage ditch north of the path in this area. This is necessary in order to avoid locating the practice both within the existing drainage ditch as well as over the natural gas pipeline. Extreme caution would be necessary in constructing the connecting pipe to avoid conflict with the gas line. If the gas line is buried too shallow to avoid this conflict, the depth of the outlet pipe (and therefore also, the underdrain) could be adjusted upward, although this would increase the level of deviation from the NYSDEC standard.

Town of Salina, Route 11 Kmart property (Site 70)

On the west side of Route 11 south of the junction with I-81, the Kmart property contains a large quantity of impervious surface. Redevelopment activity has been proposed for the site, which has been subdivided. The Kmart plaza parking lot (rear area) is scheduled to be re-developed, with design being completed over the course of 2012. The developer plans to construct a hotel along the part of the lot fronting I-81, with an additional building nearby to the north. The new buildings will be within the 100-foot setback of state-regulated wetlands. The western edge of the site is also in the 100-year flood zone. The area presently occupied by an old movie theater building (to be demolished) and the adjoining area to the immediate south, which are presently filled in with crumbling pavement and fill material spoils, will be restored and re-vegetated as part of the project. The new traffic alignment entering the development is expected to include a major driveway in the location of the existing path of travel (i.e., parallel to the east side of 81), as well as an auxiliary travel path further east, parallel to the west side of the Kmart building.

Parts of the plaza parking lot southwest of the Kmart building direct runoff due west to Beartrap Creek along the western perimeter of the site. Runoff from the eastern and northern portions of the Kmart Plaza parking lot adjacent to Route 11 enters a small drainage ditch that flows northwest to Beartrap Creek. With the exception of a drainage ditch running parallel to Beartrap Creek on the northwest side of the property and a single catchbasin about halfway along the northwest side, no drainage structures are present within the site. Although the soils are mapped as Hydrologic Soil Group D and are likely not ideal for the use of bioretention or infiltration practices, the use of sunken grassed islands remains a potential improvement over uninterrupted impervious surface. In areas where wider vegetated islands are possible, planting of small trees or inundation-tolerant native shrubs or forbs would provide an opportunity for natural uptake of runoff water and would provide better evapotranspiration than turf grass. Where feasible, it is suggested that an underdrain system be installed and connected to the existing drainage system to prevent excess accumulation of water in the grassed areas during heavy rain events. A subsurface storm sewer conveyance is known to collect runoff from the roof of the Kmart building and convey it to the catchbasin on the western perimeter of the site. Drainage and accompanying water quality benefit may be improved by connecting underdrains from the filtering practices to this conveyance system.

The parking lots on the site are rarely fully utilized. As such, the possibility of converting outer portions of the parking lots that receive the least use to pervious surface might be considered, particularly in the northern part of the site. The feasibility of using pervious pavement would depend in large part on the infiltration capacity of the underlying soils. If possible, it is recommended that an underdrain system be installed to outlet to the drainage ditch in the northwest corner of the site.

Finally, downspouts from the roof of the Kmart building are directly connected to a storm drain system that flows west to Beartrap Creek. It is possible that a portion of the runoff from these downspouts could be routed to stormwater planters along the west side of the building, although treating the entire roof with such small scale practices is unlikely due to its size. Flow-through planters are suggested, with the underdrain routed back to the storm drain system; infiltration planters may be impractical due to the underlying soil characteristics. This approach would allow at least some evapotranspiration and soil attenuation of runoff to occur.

Town of Salina, Northern Lights Plaza (Site 77)

The Town has identified opportunities to add green infrastructure retrofits to the parking lot of the Northern Lights Plaza on Route 11 immediately north of the Route 81 interchange. The primary drainage patterns on the property are toward the entrance fronting Route 11. The slope of the parking lot is generally away from the buildings, although this is most pronounced on the east edge of the lot. A stormwater conveyance line appears to capture the perimeter of the main parking lot and route flow south and then west, where flow from an additional inlet structure is received. From here, flow continues west in subsurface conveyances beneath Route 11 to Beartrap Creek. The northwest quadrant of the property is in the 100-year floodplain of Beartrap Creek. There are multiple owners in the area, with whom the Town would have to work in order to accomplish the project. The appearance of this area from Route 81 has been of concern for some time, and the addition of green spaces would be an aesthetic improvement.

Overall, Northern Lights Plaza's travel lanes are undefined and the very large concentration of impervious surface in the parking lot could be reconfigured to add bioretention areas and/or sunken vegetated islands along the drive paths. The most promising location for these vegetated islands appears to be at the ends of parking rows that front the main driving lane through the center of the parking lot. Underdrain systems could be installed to allow pollutant filtration and conveyance of drained water. The option exists to install overflow structures that would outlet to the existing catchbasin near the west end of the access drive. Also, west of the Christmas Tree Shops building, a strip of empty pavement divides the two rows of available parking. This area could be converted to a sunken bioretention island, with an underdrain and an overflow structure connecting to an existing catchbasin located at the southwest corner of the property near the exit driveway. It is likely that the water table is high in the area; a liner underneath the bioretention area should be installed at a depth sufficient to allow proper root growth. If inverts of receiving catchbasin structures are not sufficiently deep, the underdrain can be raised to a less than standard depth within the soil medium.

Opportunities to convert some of the larger existing grassed islands into sunken vegetated islands, with the addition of curb cuts, were noted. These include areas on the western perimeter of the parking lot, including the west side of the Christmas Tree Shops building and the existing island on the north side of the primary entrance drive. Suitability of soils for infiltration would require onsite examination, since they are characterized as urban fill. Vegetation selected should include native shrubs and forbs that tolerate occasional inundation; these will allow better evapotranspiration than turf grasses. Caution would be necessary to avoid disturbing underground electrical wiring and the existing pole lights located in the immediate vicinity.

Finally, pavement at the southeast corner of Northern Lights Plaza is in very poor condition and will likely be reconstructed if the adjacent building is to be expanded as planned. Depending again on the soil characteristics, the option is available to make this area pervious pavement.

Village of Solvay, Highway Garage Site (Site 83)

The highway garage site contains a grassy depressed area in the eastern portion of the property that may be suitable for stormwater treatment enhancements. Drainage to the low-lying area east of the highway garage is from a small area to the west and south, bounded by 3rd Street, Bailey Avenue, Brooks Street, and Milton Avenue. Most of the wetness and standing water in the basin is due to groundwater; the building west of the basin is a former pump house for water supply. The basin was once a fountain pool and contains an old tile drain along its east side that has likely disintegrated. The basin collects drainage from the south and west. It drains to the storm sewer system along Milton Avenue; a sump was installed in the pipe to collect sediment and to lessen the velocity of flow from the pipe. This system carries flow west and then north beneath railroad tracks to a wetland that eventually directs flow to Geddes Brook.

Because of poor-draining soils, improvements would likely involve installing an underdrain to improve drainage and promote pollutant removal through filtration. The opportunity is present to funnel runoff from part of the highway garage parking lot to a modified water quality dry swale, although the Village should be aware that the parking lot is likely a "stormwater hotspot", and any infiltration of runoff into the ground would be precluded if this is done. The practice would require pretreatment in a settling basin, and the bottom of the swale would be isolated from the groundwater table by a geotextile liner. The liner would disallow infiltration, effectively allowing the swale to function as a filtering practice.

A major logistical obstacle may be the presence of two 15-inch water mains that cross the low-lying area. Although both are believed to be at least five feet below ground, and underdrains could be installed at least 10 feet away as required by code, it may still be difficult to locate the swale such that conflicts are avoided. The system would be a linear feature remaining narrow enough that it can be positioned between the existing water lines with sufficient distance provided, and the perforated pipe and gravel underdrain system would be entirely lined with geotextile fabric on all sides, top, and bottom. Although the Health Department would likely object to water being deliberately infiltrated in an area harboring potable water conveyances, this concern may also be addressed by the use of an impermeable liner underneath the practice.

Use of a dry swale equipped with an overflow structure would remove pollutants while also reducing runoff through uptake by vegetation, thereby improving drainage. It is suggested that the existing turf grass be replaced by more diverse vegetation tolerant of periodic wet conditions, to maximize evapotranspiration benefits. The system would be oriented flowing west to east away from the highway garage to optimize the drainage area treated. A slight pitch would need to be added to the presently flat surface to provide needed hydraulic drop. If the pre-existing tile drain can be located, it may need to be relocated or replaced to allow connection to the new catchbasin used as an overflow structure from the swale, and accordingly connected to the existing storm sewer system along the railroad tracks parallel to Milton Avenue.

Village of Solvay, Triangle @ Trump/Power Streets (Site 84)

Near the intersection of Milton Avenue and Cogswell Avenue in Solvay, localized flooding occurs during moderate to heavy rain events as catchbasins overflow into a ditch along the railroad tracks and into neighboring parking lots. The narrow strip of land owned by Honeywell International Inc. along Milton Avenue provides minimal opportunity for any drainage improvements. Because space is limited, a linear in-line treatment system would be the only option along Milton Avenue itself; pervious pavement or other small-scale green infrastructure practices would not be feasible due to the amount of runoff entering the area. Opportunities to reduce runoff higher in the watershed were therefore examined.

The system that drains immediately to the aforementioned ditch in the problem area originates on Cogswell Avenue and Kings Avenue to the south. However, additional drainage systems that enter the ditch to the west likely impact the problem by contributing additional runoff to the system downstream that impedes drainage west to Geddes Brook. These include the systems along Center Street and Abell Avenue. Two parcels of land owned by the Village at Trump, Power, and Center/Gillis Streets provide an opportunity to control some of the runoff to the system by utilizing green infrastructure. These parcels ultimately drain to South Avenue, which is part of the Abell Avenue system. The larger parcel, a triangular piece of land centered at the crossroads of Trump, Power, and Center/Gillis Streets, is presently a little-utilized pocket park, and the opportunity exists to beautify the landscape while reducing phosphorus loading to Onondaga Lake.

The bioretention area in the center of the triangle would most readily be located in the eastern part of the south corner, which is the lowest spot in the landscape and permits immediate access to an existing drop inlet on Center Street. Curb cuts will be necessary to bring runoff into the practice from Center and Trump Streets. The other bioretention practice would be constructed on the northeast corner of Trump and Center/Gillis Street intersection. A curb opening would need to be constructed across the curb and gutter system on Trump Street. The option exists to construct either or both of these bioretention areas.

A telecommunications service box exists on the north side of the “triangle” (Power Street), suggesting that the area is bisected by telephone and/or cable lines. The exact location and depth of the transmission cables would need to be ascertained prior to undertaking design. Also, poles supporting overhead utility wires bisect the triangle in a north-south orientation, so caution would be needed to restrict construction activity to the area east of these poles.

Village of Solvay, Youth Center Slope Stabilization (Site 86)

A very steep slope (1:1 in places) exists behind the Solvay Youth Center on Woods Road, and is experiencing severe erosion. The hill ranges from approximately 25 to 150 feet in height above the adjacent parking lot to the west, and sediment is being carried into the parking lot and down the eastern extension of First Street with every major rain event. The velocity and volume of the resulting flow has also caused damage to First Street to the west of the site. An analysis of storm sewer system mapping, topographic mapping, and aerial photography appears to indicate that drainage from this site enters an east-flowing ditch along Milton Avenue, which is diverted north into a closed pipe system that flows north to Industrial Drive. From here, it enters a ditch that carries flow southeast along Willis Avenue to the mouth of Harbor Brook.

One option to stabilize the hillside is to re-grade it to a lesser slope (likely through use of terracing), install rolled erosion control fabric, establish dense turf cover, and perhaps introduce woody vegetation through use of biotechnical planting techniques. The distance from the toe of the eroding slope to the edge of the parking lot generally ranges from 30 to 40 feet, although it is greater near the northwest end of the slope where the height of the hill is much less. Because of the necessary adjustments to the slope, it is likely that the toe of the slope must be pushed outward to near the edge of the parking lot. To achieve a stable grade, re-shaping will also be necessary up to the top portion of the hillside (i.e., the east/north (upper) end of the slope would be flattened outward, likely extending further uphill than the eroded area). The terraced pattern is expected to be necessary because there is not likely to be sufficient horizontal distance to achieve a consistent stable grade. Because of the unconsolidated material of the slope, amendment with topsoil and perhaps the use of a turf reinforcement mat is also recommended. Utility poles supporting overhead wires are present around the perimeter of the parking lot, and caution will be needed to keep slope stabilization outside of the poles. Flattening of the west/south (lower) end of the slope may need to be restricted to about 20 feet outward unless the poles can be moved further west/south.

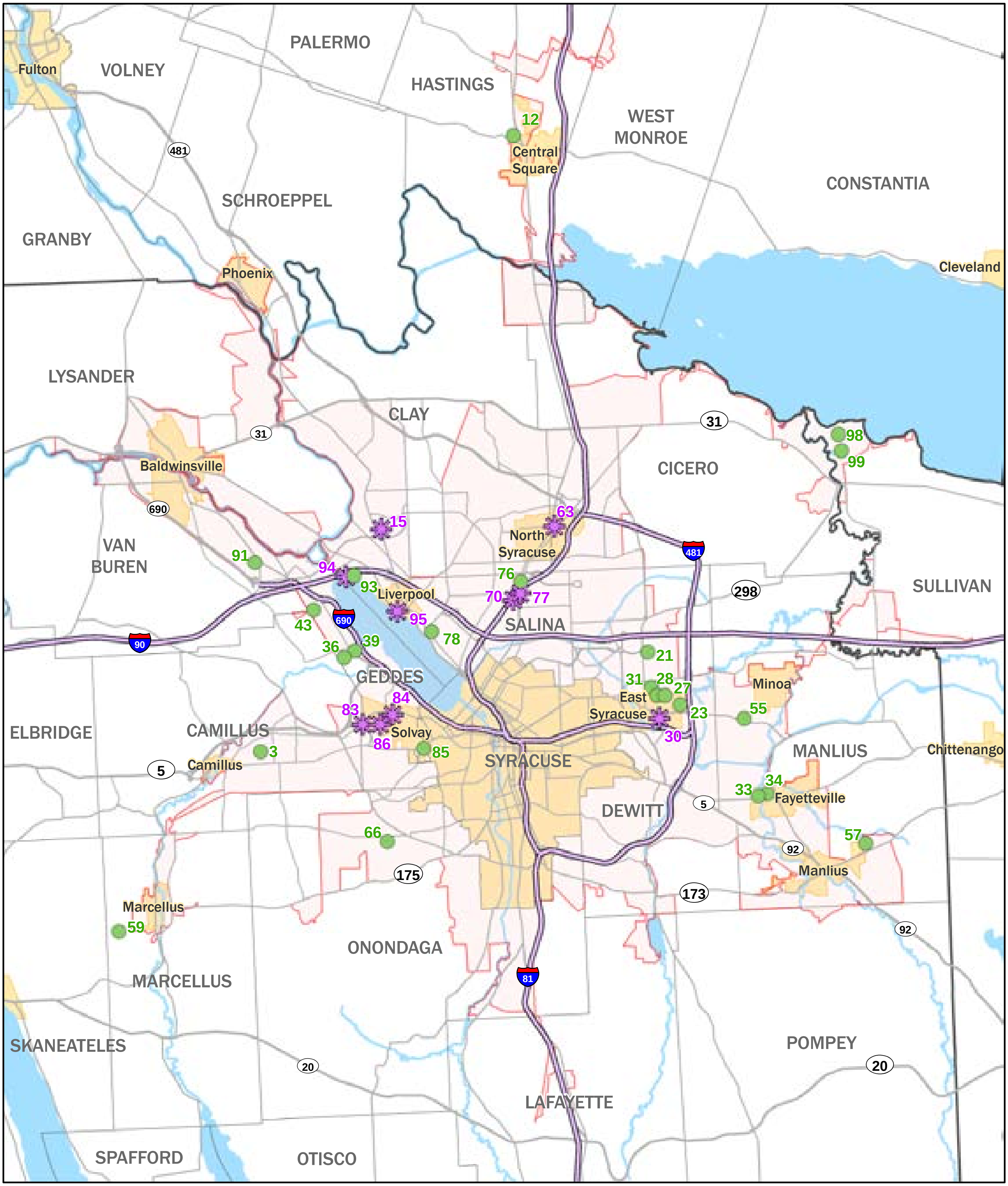
An opportunity also exists to control both the velocity and water quality of runoff from the eroding hillside. An existing drainage ditch containing some detention capacity is present along the north side of the Youth Center property. Flow from the north half of the parking lot pitches toward the ditch. A 12” pipe exits the west side of the ditch. Upon field investigation, it is apparent that this pipe connects to an existing catch basin structure at the bottom of First Street where it intersects Woods Road. The ditch could be converted to a Type O-1 dry swale or bioretention area with installation of an outlet structure and underdrain at its west end, where the outlet pipe currently exists. The bioretention area or swale must be situated so as to avoid the utility poles, or they may need to be relocated. To maximize stormwater capture from the parking lot perimeter as well as aesthetic and educational benefit, bioretention would probably be the most effective practice.

In the area to the north of the parking lot, where the height of the slope is the least, the Village has considered the option of installing a green wall to allow sufficient space for bioretention to be situated at the toe of the slope, rather than flattening the slope and sacrificing remaining space between the slope and parking lot. The green wall would likely be composed of planter blocks containing soil and vegetation, possibly including a network of irrigation tubes.

There are several areas around the Youth Center building in which stormwater planters could be situated, most notably at a pair of downspouts on the east side of the building next to the air conditioning unit. The possibility of converting this part of the parking lot in the rear of the building to pervious pavement was also discussed. The lot occasionally fills up but is generally used only as overflow parking.

Appendix A

Map of Level 2 and 3 priority sites



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0 1 2 4 Miles

ARRA Green Infrastructure: Level II & III Priority Sites

Legend

- Level III Site
- Level II Site
- SUA

December 2011
This map was created for planning purposes only.
CNY RPDB does not guarentee the accuracy or completeness of this map.

Appendix B

Descriptions of Level 2 and 3 priority sites

Green Infrastructure Planning for Improved Stormwater Management in Central New York - High Priority Sites

Site ID	Municipality	Location	Problem or opportunity description	Potential practices to consider	Key benefits	Watershed
3	Town of Camillus	Orchard Village and Camillus Park	In the Orchard Village subdivision, an eroding gully is forming between Northwood Way, North Way, and East Way, and spreading upstream southeast to Camillus Park. Camillus Park is slated to undergo a number of improvements in accordance with a Parks Department Master Plan, currently under development, and may consider application of green infrastructure features, which may reduce runoff entering the gully.	Pervious pavement in the parking lot was discussed as one way to lessen the runoff volume. The semicircle east of the parking lot and little-used athletic field west of the parking lot may also contain opportunities for green infrastructure practices such as bioretention, infiltration basin, etc. However, since the Town is in the process of developing a Master Plan for the park, any such improvements would need to be coordinated with the Master Plan.	Runoff volume reduction and water quality treatment for phosphorus	Ninemile Creek
12	Village of Central Square	US Route 11 southwest of County Route 12 and vicinity	Poor drainage and backups occur along County Route 12 and in the vicinity of the Moore High School facility. These areas flow to a tributary of Oneida Lake that periodically overtops its banks to the south at Thelma and Ruth Drives, particularly when Oneida Lake is at high water level.	Where feasible, closed drainage systems might be replaced with open swales where uptake by vegetation may provide some reduction of runoff volume and improve infiltration capacity. A possible option that was discussed was conversion of the mucklands north of County Route 12 to restored wetland with the capacity to retain stormwater while also providing habitat. The Village intends to contact the current owner of the land, who might be interested in a USDA-NRCS Wetlands Reserve Program arrangement.	Runoff volume and peak flow control; water quality treatment for sediment and phosphorus	Oneida River
15	Town of Clay	Bayberry Planned Development	In the Bayberry neighborhood, footer drains are presently connected to the sanitary sewer system, and in heavy rainstorms the system is overwhelmed and cannot handle the additional flow. This results in overflows at the Wetzel Road treatment plant to the Seneca River. Backups of raw sewage into basements also occur.	In common greenspace areas, opportunities exist for the installation of bioretention to capture drainage from closed systems within various parts of the neighborhood. This drainage would need to be daylighted to the surface and/or conveyed to the practices using flow splitters. Areas where this approach may be feasible include northeast of Cardinal and Dove Paths, west of Damson Lane, south of Berrywood and Forester Roads, and northwest of Foxberry Lane. Addition of a water quality swale between Gooseberry Lane and the end of Forester Road might be accomplished by a similar method. The basketball court west of Quail Path could be resurfaced with porous pavement.	Runoff volume and peak flow control, reduction of discharges of pathogens, nitrogen, phosphorus, and floatables	Seneca River
21	Town of DeWitt	Franklin Park Development	Nuisance flooding and inundation of roadways occurs during heavy rain in the Franklin Park development due to inadequate drainage and lack of sufficient grade. Flooding occurs particularly in the area of Lyndale Court and Greentree Drive and the intersection of Winchester Road and Franklin Park Drive, but also in other isolated areas.	The common area in the north half of Barton Circle may be a potential location for a significant practice such as bioretention as a demonstration project. If the bottom elevation of the practice is sufficiently below existing grade, it would receive runoff from Winchester Road, perhaps providing some relief to areas immediately south of it. Overflow could probably be directed to the system along Franklin Park Drive. Also, it appears that an easement exists inside the circle of Lynndale opposite the west end of Richwood, another possible opportunity for bioretention. A rain barrel or stormwater planter program, if widely adopted, might lessen the runoff volume in smaller storms.	Runoff volume reduction, water quality treatment for phosphorus	Ley Creek

Note: Shaded areas represent Level III Sites, which hold the highest potential for implementation.

Site ID	Municipality	Location	Problem or opportunity description	Potential practices to consider	Key benefits	Watershed
23	Village of East Syracuse	East of Mosher Avenue and Dausmann Street	Localized flooding occurs in the area east of the Mosher Street cul-de-sac. The cul-de-sac area, which is elevated higher than Mosher Street, is presently the proposed site of two tanks that would be used to alleviate a sanitary sewer overflow. The area drains east to a designated NYS wetland. However, part of the wetland was filled in with construction of a new golf course, and the drainage channel carrying flow to the wetland was blocked. The Village has considered restoring the wetland to the east as an alternative means of treating flows, in order to avoid the expense of tank construction.	A wetland restoration in the area might be permitted by NYSDEC to treat the SSO instead of constructing storage tanks. Pathogens could be removed using a system similar to that in Minoa if wetland improvement is designed and constructed properly. Also, if inundation is periodically a problem in the area at the end of Mosher Avenue, a small vegetated island could be added at the center of the cul-de-sac in attempt to infiltrate some of the stormwater to lessen the backup from the blocked culvert.	Water quality treatment for phosphorus and sediment, runoff volume reduction	Butternut Creek
27	Village of East Syracuse	East Syracuse Free Library - West Henrietta Street	East Syracuse Free Library contains a roof leader that is connected to the MS4. Opportunities exist to disconnect the leader to a green infrastructure practice and/or incorporate other green infrastructure practices on the property, with educational components.	The west side of the library contains a grassed area that could support a rain garden, although conflicts with utilities would need to be resolved. Pervious pavement could replace the existing surface beneath an overhanging roof on the east side of the building, and it may also be possible to utilize stormwater planters. The wide, large parking lot at the rear (north) of the building could probably support a series of bioretention cells down its center. Catchbasins on James Street appear to be situated to allow connections of overflows and underdrains.	Runoff volume reduction, water quality treatment for phosphorus	Butternut Creek
28	Village of East Syracuse	Hartwell Avenue - Firemans Field	Occasionally, major puddling of water occurs in the gravel lot known as the "Firemen's Field" used for "Field Days", a recreational event held by the Village. Adjacent ditches are slow-moving and do not drain well.	Soil restoration is recommended to reduce compaction in the area and promote infiltration. A crushed stone layer could be added on top of this using grid pavers to maintain grade and lessen compaction. Underdrains might be installed in the ditches to carry excess water if the infiltration rate is insufficient without them; an existing drainage ditch along the west edge of the larger lot could perhaps support a dry swale or a wet swale.	Runoff volume reduction, water quality treatment for phosphorus	Butternut Creek
30	Village of East Syracuse	Bagg Street highway garage	Village highway garage on Bagg Street contains areas of standing water between its two primary buildings that freeze and damage the pavement. Opportunities to reduce runoff volume and improve runoff water quality may exist.	A possible solution that was discussed was to install a a modified filtering structure with an underdrain underlying a layer of sand down the center line of the property between the buildings, with two sets of baffles, carrying most or all flow toward Bagg Street. A roof leader on the southeast corner of the larger north building discharges into the parking lot very close to a grassed area east of the building; this downspout could be extended and redirected to flow around the corner of the building to the grassed area, where a rain garden or bioretention area could be created.	Runoff volume reduction, reduction of discharge of sediment, oil/grease, and chlorides from runoff	Ley Creek

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Green Infrastructure Planning for Improved Stormwater Management in Central New York - High Priority Sites

Site ID	Municipality	Location	Problem or opportunity description	Potential practices to consider	Key benefits	Watershed
31	Village of East Syracuse	Ellis Park - McCool Avenue	A failing stormwater management practice at Ellis Park northwest of Irving Street and McCool Avenue was constructed to treat runoff from facilities expansion. It was designed as a bioretention area, but presently contains stone instead of a soil mixture. Weeds overtake the basin during the summer and make maintenance impossible.	Adding geotextile overlain by four inches of topsoil was discussed. If an underdrain is not present, it should be installed. Native grasses could be planted and maintained by hand mowing. To enhance plant uptake of water, a few native shrubs should also be established in the area; these can be placed so as to not inhibit maintenance.	Water quality treatment for phosphorus	Butternut Creek
33	Village of Fayetteville	Canal Landing Park at Limestone Plaza	A branch of the trail at the new Canal Landing Park continues north along the west bank of Limestone Creek to the site of the former dam. This section of the trail is currently in stone dust surface; the Village is interested in converting it to flexi-pave surface. A stretch of approximately 50 to 100 feet of the east bank immediately downstream (north) of the former dam contains significant erosion and near vertical slopes.	The use of pervious pavement surfaces on the trails is appropriate; the Village indicates that on-site investigation of the soils in many areas has determined them to be sandy/gravelly soils with a very high infiltration rate. The project is presently in design and includes re-shaping of the slope as well as the introduction of some biotechnical stabilization techniques, in addition to hard engineering, to address sediment loss from the bank. Vegetated rain garden areas are also planned along the trail to capture additional runoff.	Reduction of erosion, water quality treatment	Limestone Creek
34	Village of Fayetteville	Feeder Street/Brooklea Drive	The Village plans to add a sidewalk in front of the Manlius Town Hall and wishes to use pervious pavement. In the adjacent Little League fields, the Village is interested in using pervious pavement in the parking lot and along the third base line of the southern baseball diamond.	The new sidewalk could utilize flexible recycled rubber pavement instead of conventional concrete. The Village has considered replacing part of the existing parking area adjacent to the Little League diamond as well as the third baseline access pathway with flexible recycled rubber pavement instead of standard asphalt or concrete. The remainder of the parking lot closer to the entrance from Feeder Street will be a traditional surface, but the opportunity exists to add green features such as bioretention along the perimeter to capture runoff.	Runoff volume reduction	Limestone Creek
36	Town of Geddes	Smelkoff Drive and State Fair Blvd.	Standing water is present in backyards and basements behind Smelkoff Road. The ditch carrying the stream behind Smelkoff Road is choked off, and major ponding occurs in yards. Immediately downstream, thirteen acres of prime developable land exist on property at 740 State Fair Boulevard, but poor drainage and the presence of wetlands has deterred development.	Wet swales and/or pocket stormwater wetlands hold the best potential due to limitations imposed by high water table. One location for a possible stormwater practice (pond, wetland, or large bioretention area(s)) is at the intersection of State Fair Boulevard and Smelkoff Road on the State Fair/ Smelkoff property, which is proposed to be developed. There has also been discussion of restoring/enhancing the existing wetland area on the 740 State Fair Blvd. property.	Phosphorus reduction, flood/peak flow control	Onondaga Lake south
39	Town of Geddes	Pope's Grove Golf Course	Inadequate drainage and lack of grade result in flooding south of Laura Drive and Scorpio Drive, causing flooding of backyards as well as the west side of the Pope's Grove golf course.	Any changes to the site would require permission and concurrence from the property owners of the Pope's Grove golf course. As an option to address the excess standing water and flow levels in the tributary, the Town might consider tree-planting on the golf course. The fairway of the westernmost hole of the golf course, which borders the backlots of Laura Drive, could perhaps be narrowed by widening the belt of trees along its north side. Soil restoration should also be attempted in the area. One other possible alternative the Town may wish to consider is to add a dry swale along the northern perimeter of the westernmost hole on the golf course.	Runoff volume reduction, water quality treatment (phosphorus)	Onondaga Lake south

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Green Infrastructure Planning for Improved Stormwater Management in Central New York - High Priority Sites

Site ID	Municipality	Location	Problem or opportunity description	Potential practices to consider	Key benefits	Watershed
43	Town of Geddes	Lakeside Road/ State Fair Blvd.	A large area containing a waterway originating at Beach Road floods on a regular basis, with drainage originating in the Towns of Van Buren and Camillus. Drainage along Lakeside Road takes a turn to the north immediately adjacent to the porch of a residence, threatening property damage. Further north (downstream) the same drainageway also creates periodic flooding at a motel on the west side of State Fair Boulevard, and at United Freezers on the east side.	The possibility of incorporating offline storage volume for flow that overtops the banks of the small stream at the proposed future development site should be investigated. Restoring or augmenting natural floodplain through use of pocket wetlands may help to mitigate the severity of the downstream flooding and erosion issues. The developed portion of the drainage area offers two opportunities to infiltrate stormwater runoff volume: (1) the cul-de-sacs of Scarlet Circle and Hickman Court are very large and are underlain by Ontario (B) soils; sunken vegetated islands could be introduced at the center to both receive runoff and reduce impervious, or the perimeter could be reduced; (2) the right-of-way on the north side of Beach Road should be examined for locations in which stormwater infiltration can be obtained. At the extreme upstream part of the drainage ditch system, an opportunity may exist to utilize vegetated or water quality swales as a means of capturing and infiltrating stormwater.	Runoff volume and peak flow reduction and control	Seneca River
55	Town of Manlius	Manor Drive/Sunset Drive	Nuisance basement and yard flooding is experienced in the Manor Drive neighborhood. Most drainage has negligible grade, with both pipes and catchbasins very close to the surface, and ditches and berms that run through some backyards have been altered by residents.	A triangular piece of open space is present in the right-of-way at the Manor Drive/Sunset Drive intersection that may be able to handle runoff as a rain garden or similar practice (it sits between two slight ridges and would likely take some runoff from E. Manor Drive). Also, sharp corners at several angled intersections along Manor and Sunset Drives have effectively created a locally wider right-of-way. These corners are strategically located to capture runoff, and soils may be adequate to promote infiltration. Drainage generally is directed toward Manor Drive and the west part of Sunset Drive from both north and south; practices implemented at the corners might intercept some runoff before it accumulates in the main conduit street. South of Manlius Center Road, additional opportunities exist, including a large vegetated island in the center of Wilson Circle (overhead utilities may be a conflict) that may receive drainage from the north on Wilson Drive, and wide corners at the intersections of Wilson Drive with Osborne and Burdick.	Nuisance flooding alleviation, runoff volume reduction, water quality treatment for sediment and phosphorus	Limestone Creek/ Butternut Creek
57	Town of Manlius	Falcon View Development	Flooding of yards and streets occurs in a few isolated locations. One particular area of ponding about 400 feet north of the northern intersection of Tinderbox Circle and Turnstone Drive is by far the most significant. It is believed that this area is in the middle of the former course of the stream that was relocated to the east side of the development.	Downspouts could be routed to dry wells. Rain gardens, bioretention or vegetated swales could be established in areas where feasible (using curb cuts if necessary). An easement exists in the center of Stratus Circle and may be a possible location for a bioretention area. This may alleviate flooding complaints in the area (sump pumps could be directed to discharge to it). Other locations under consideration for swales or bioretention include the semicircle between the intersections of Tinderbox Circle and Turnstone Drive, between Tinderbox and Turnstone just south of Tuft Road, near the most significant flooding area, and at the end of the Tinderbox cul-de-sac (northwest of it), where a drainage easement exists.	Runoff volume reduction, water quality treatment for phosphorus	Limestone Creek

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Green Infrastructure Planning for Improved Stormwater Management in Central New York - High Priority Sites

Site ID	Municipality	Location	Problem or opportunity description	Potential practices to consider	Key benefits	Watershed
59	Town of Marcellus	Deer Path Circle	The Deer Path/Browsing Lane subdivision contains a small dry detention pond at the south end of Deer Path Circle. A ditch enters the pond as a pilot channel and remains channelized through to the opposite end of the pond; no standing water was present in the remainder of the pond.	The existing detention pond could perhaps be converted into a wet pond ("extended detention pond"). A permanent pool would need to be established at a definite elevation; the outlet structure may have to be adjusted or replaced for this to occur, and the pond may need to be deepened. A forebay with a level spreader at the inlet and an adequate aquatic bench would need to be established, so some additional storage volume would likely need to be added. A bioretention area or rain garden could be installed in the grassed island at the end of Deer Path Circle. Finally, the outfall from the east end of Browsing Lane currently discharges into a vegetated area with only some outlet protection; a level spreader could be added to fully disperse the flow.	Phosphorus and sediment treatment	Ninemile Creek
63	Village of North Syracuse	Centerville Place/Trolley Barn Lane	Inundation periodically occurs near the intersection of Trolley Barn Lane and Centerville Place, including during moderate rain events. It is known that the drainage issue is due to backup of water in pipes that do not adequately convey runoff to an existing detention pond.	The existing 18-inch pipes should be replaced with larger diameter pipes to enable water to reach the detention pond. One option is to install an outlet structure on the pond that would allow the drainage to leave the basin slowly, creating a wet pond with permanent pool. A small settling basin should be incorporated into the design to catch sediment at the inlet. The outlet could probably be connected to an existing catchbasin near the northwest corner of Trolley Barn Lane and South Bay Road. A small quantity of runoff could be removed from the system using a rain garden and/or stormwater planters at the library, which would provide an educational demonstration project as well as an attractive landscape feature. The use of sunken islands and/or pervious pavement throughout the development was noted as another possibility. An existing dry well at the northwest corner of the Community Center parking lot receives drainage from the parking lots of the church to the north. A bioretention area could be added to enhance water quality treatment while promoting infiltration, although design must be coordinated with plans to convert the aera to a pocket park.	Runoff volume reduction, runoff volume and peak flow control, water quality treatment for sediment and phosphorus	Mud Creek/ Oneida River
66	Town of Onondaga	Limehill Road/Howlett Hill Road	A retrofit opportunity exists east of Limehill Road at Howlett Hill Road in an area that has experienced some drainage and erosion problems. The existing detention basin currently contains some standing water in it on a regular basis.	The Limehill Road dry pond might be converted to an infiltration basin with addition of forebay and possible native vegetation plantings, assuming soils are appropriate. A micropool extended detention design would be the other option if hydraulic and soil conditions are met. The possibility of promoting runoff reduction at the cul-de-sacs on Collier and Croft Circles (and also perhaps Carrigain) has been considered; the Town is interested in decreasing the perimeter areas of the cul-de-sacs, changing the outside cover to vegetation, and allowing water to sheet flow off the impervious center.	Runoff volume and peak flow control, nutrient (phosphorus) treatment	Harbor Brook

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70	Town of Salina	Route 11/Kmart Plaza	The median of Route 11 has recently been reconstructed, but contains sunken areas where catchbasin structure rims could be raised to create bioretention areas. The adjacent Kmart plaza parking lot may be reconfigured with the addition of a proposed hotel, and the Town is interested in adding green areas to define the driving lanes at that time.	Within the Route 11 median, changes to plantings and raising the frame on existing catchbasins (where possible without risking flooding of road), and introducing sunken islands where curb cuts exist, could perhaps be coordinated with NYSDOT. The Town could also add bioretention areas along entrance and access lanes within the parking lot of the Kmart. Replacement of old buildings with greenspace is also a possibility; soil restoration and tree planting could be components of this effort. The Town would need to work with the property owners in order to proceed.	Runoff volume reduction, water quality treatment for phosphorus and sediment	Beartrap Creek/Ley Creek
76	Town of Salina	Lawrence Road/South Bay Road/Route 11	The Route 11/South Bay Road area between I-81 and Col. Eileen Collins Boulevard consists of a large patchwork of impervious paved areas. Some of the parking lots are not set apart by travel paths but are directly parallel to and connected with existing roadways, particularly at a plaza north of Lawrence Road; an opportunity may exist to incorporate green areas with stormwater management functions.	The plaza north of Lawrence Road between South Bay Road and Route 11 contains areas along the edges of its parking lot, within the Lawrence Road right-of-way, that currently contain uninterrupted pavement. Drainage from the parking lot is generally away from the plaza buildings and Route 11 and South Bay Road toward the south central part of the parking lot. Small bioretention areas or vegetated swales could be added within the right-of-way to better define the parking lot and separate it from the surrounding roads. The Town would need permission from the property owner in order to proceed.	Runoff volume reduction, water quality treatment for phosphorus and sediment	Beartrap Creek/Ley Creek
77	Town of Salina	Northern Lights Plaza	The plaza contains a very old parking lot in poor repair. The Town is considering adding greenspace areas to define travel lanes when the lot is resurfaced. Behind the Staples building, a non-maintained paved area exists in which an access road may be created if re-development occurs.	An existing grassed island west of the Christmas Tree Shops building offers one opportunity to install bioretention. Bioretention is suggested to define the remainder of the north entrance drive proceeding east. Bioretention areas could also be utilized to define the driving lanes immediately north and west of the plaza buildings. Abandoned properties east of the plaza, including parts of the paved area that may be re-developed, could be returned to greenspace using soil restoration and planting of vegetation. The Town would need permission from the property owners in order to proceed.	Runoff volume reduction, water quality treatment for phosphorus and sediment	Beartrap Creek/Ley Creek
78	Town of Salina	Old Liverpool Plaza	Plaza at intersection of Electronics Pkwy and Old Liverpool Road is bounded to the west and south by strips of greenspace. The parking lot could be reconfigured to infiltrate stormwater to this area.	Bioretention with curb cuts as either parking lot islands or in the median space at the intersection of Old Liverpool Road and Electronics Parkway is an option that might be considered. If work is to be done in the parking lot itself, owner cooperation would be necessary before proceeding.	Runoff volume reduction, water quality treatment for phosphorus and sediment	Bloody Brook
83	Village of Solvay	Milton Avenue/Bailey Avenue highway garage	An opportunity was identified to improve water quality within the drainage system to a large wetland complex north of Milton Avenue: the highway garage site contains a low-lying grassy area in the eastern portion of the property that may be suitable for a retrofit.	In the green space on the eastern half of the property, the low-lying shallow basin east of the highway garage may be a good location to implement a dry swale or a sand or organic filter.	Runoff volume reduction, water quality treatment for phosphorus and sediment	Geddes Brook

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84	Village of Solvay	Cogswell Road/Milton Avenue drainage system	Localized flooding occurs as catchbasins overflow into ditch along railroad tracks and neighboring parking lots on a narrow strip of land along the north side of Milton Avenue near its intersection with Cogswell Avenue.	Pervious pavement in the parking area south of the entrance to the fire garage on Pennock Street, replacement of the adjacent basketball court with porous concrete or asphalt (or outright removal and soil restoration), bioretention in the area behind the ballfield, or stormwater planters receiving roof runoff from the building(s) are possibilities. The triangular parcel known as the "V" at the corner of Gillis, Center, and Power Streets might support a bioretention area or infiltration basin that could reduce the problem drainage area. The area to the southeast of the "V" (triangle) at Trump Street is flatter than the space within the triangle itself and may be a better location for bioretention than the "V" itslef. The "V" does not drain to the Cogswell area but enters the same drainage ditch along Milton Avenue downstream of the flooding area; hydraulically the system likely affects the other.	Runoff volume reduction, water quality treatment for phosphorus and sediment	Geddes Brook
85	Village of Solvay	Montrose Avenue	Localized flooding occurs as catchbasins back up in heavy rain on Montrose Avenue between Genesee Street and Hamilton Street. The catchbasins regularly are clogged with sediment originating from an eroding slope extending uphill to Crestview Terrace to the east.	Where access is available on the west side of Crestview, a substantial open gravelly area denuded of vegetation exists. If stabilized with erosion control fabric and vegetation, erosion and runoff volume would both be reduced, although agreement from the property owner would be necessary.	Erosion control, sediment control	Harbor Brook
86	Village of Solvay	Woods Avenue Youth Center	A hillside behind the youth center adjacent to the Village and Town office facilities, owned by the Solvay Tigers Athletic Club, is severely eroding. A length of approximately 500 feet adjacent to the parking lot is cut to an approximately 1:1 slope, and contains significant rill and gully erosion. A small detention basin exists to the north of the parking lot but does not adequately control runoff from the area.	Permission from the Athletic Club would be needed in order to proceed; the owner has been contacted and has indicated an interest in working with the Village on the project. Terracing accompanied by high-density erosion control fabric would most likely be the approach used, and shrub vegetation could be established in addition to grass to improve slope stability. There is sufficient space between the toe of the slope and the parking lot for reshaping of the hillside to form terraces and/or flatten out the slope. The existing ditch north of the parking lot could be converted to a a bioretention area or Type O-1 dry swale with installation of an outlet structure and underdrain at its west end, where an outlet pipe currently exists. Stormwater planters might also be situated to capture roof runoff from downspouts on the Youth Center building. Pervious pavement in the parking lot has also been discussed.	Erosion and sediment control, runoff volume reduction, water quality treatment for phosphorus and sediment	Harbor Brook
98	Town of Sullivan	North Road south of Damon Point Road	Backup of water occurs on the east side of North Road. Overflow and flooding of the banks west (downstream) of North Road occurs during heavy or prolonged rain events. At North Road immediately south of Damon Point Road, the drainageway is believed to require cleanout all the way to Fisher Bay marina; it had been channelized but has lost capacity due to erosion and sedimentation.	Permission and cooperation of the neighboring landowner would be necessary before undertaking any work. A retrofit of the ponding area east of North Road to a standard wetpond to improve storage capacity, residence time, and hydraulics may be useful, including water quality pretreatment to contain sediment.	Flood control, runoff volume and peak flow reduction	Chittenango Creek

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Site ID	Municipality	Location	Problem or opportunity description	Potential practices to consider	Key benefits	Watershed
99	Town of Sullivan	North Road between Hitchcock Point Road and Shackleton Point Road	Significant overbank flooding occurs on the east side of North Road. The stream on the west side of the road is downcutting with a significant drop in the stream level, and bank erosion is occurring. The 60-inch culvert under North Road at this point does not appear to be fully functioning. There is also major inundation on a regular basis further upstream at Shackleton Point Road, where two 50-inch culverts are unable to properly convey flow due to lack of grade.	A possible mitigation action for the problems might be to install vegetated swales or wet swales along Shackleton Point Road, both west and east of the stream crossing. Although the groundwater table is very high in these areas and the grade is very level, the limited opportunity for infiltration should be maximized, with the added benefit of encouraging some water quality improvement in Chittenango Creek and Oneida Lake. A small-scale streambank stabilization project might also be undertaken immediately west (downstream) of North Road.	Runoff volume and peak flow reduction, erosion and sediment control	Chittenango Creek
91	Town of Van Buren	Seneca Knolls development (Baker Road/Jones Road)	Drainage from the area of Hosmer, Snowdale, Blanchard, Leopold, etc. is presently directed to a ditch south of Baker Road, which is eroding. At the east end of the ditch, flow is received from the area to the north (Rufus Drive and vicinity). A bottleneck exists where flow from the neighborhood is forced into a 30" culvert as it enters the Baker Road ditch, which flows along the Soccer Center property.	The Soccer Center has agreed to allow construction of a stormwater treatment pond or wetland on its property to which some of the excess flow can be diverted and stored. The Town plans to use open vegetated swales to connect drainage areas to the pond. Backlot drainage from the area to the west is directed toward the pond site via a drainage ditch along the south side of Baker Road; this ditch may be connected to the proposed pond. The ditch currently contains areas of significant erosion, so the Town is planning to fill and regrade the ditch area. Soil restoration and installation of a vegetated swale are possibilities here.	Peak flow control, runoff volume reduction, water quality treatment for phosphorus	Seneca River
93	Onondaga County	Onondaga Lake Park - Parkway spur road loop near north entrance	In the Willow Bay Section of the Park, the center between two spur roads of Onondaga Lake Parkway contains frequent standing water, especially during and after heavy rain events.	The wet area inside the "loop" could perhaps be transformed into an aesthetically pleasing pocket pond or wetland with an aquatic bench. Overflow might be directed to the feeder canal or to Onondaga Lake.	Water quality (phosphorus) treatment	Onondaga Lake north
94	Onondaga County	Onondaga Lake Park traffic circle/parking lot at entrance by Thruway	In the Willow Bay Section of the Park at the Entrance Road directly under the Thruway overpass and at the traffic circle turn-around, poor drainage and ponding of water occur during heavy rain events, particularly associated with drainage ditches along the Thruway.	The area inside the traffic circle between two parking lots immediately south of the NYS Thruway, and several other areas adjacent to the parking lots, could be converted to sunken vegetated islands. Existing ditches around the perimeter of the west parking lot could be converted to water quality dry swales flowing to Onondaga Lake Outlet. Existing ditches adjacent to the east parking lot could be enhanced as vegetated swales outletting to the feeder canal.	Runoff volume reduction, water quality treatment for phosphorus and sediment	Onondaga Lake north
95	Onondaga County	Onondaga Lake Park recreation trail south of Village of Liverpool	Along the East Shore Recreation Trail between Sycamore Street and Birch Street, drains from neighboring backyards uphill are discharged at the bottom of the slope and cause accumulation of water alongside the trail.	Bioretention areas could be constructed along the north side of the recreation trail in wet areas to promote water quality improvement and also improve drainage of the water to Onondaga Lake. The practices could be connected directly into the existing drainage system.	Runoff volume reduction, water quality treatment for phosphorus	Onondaga Lake north

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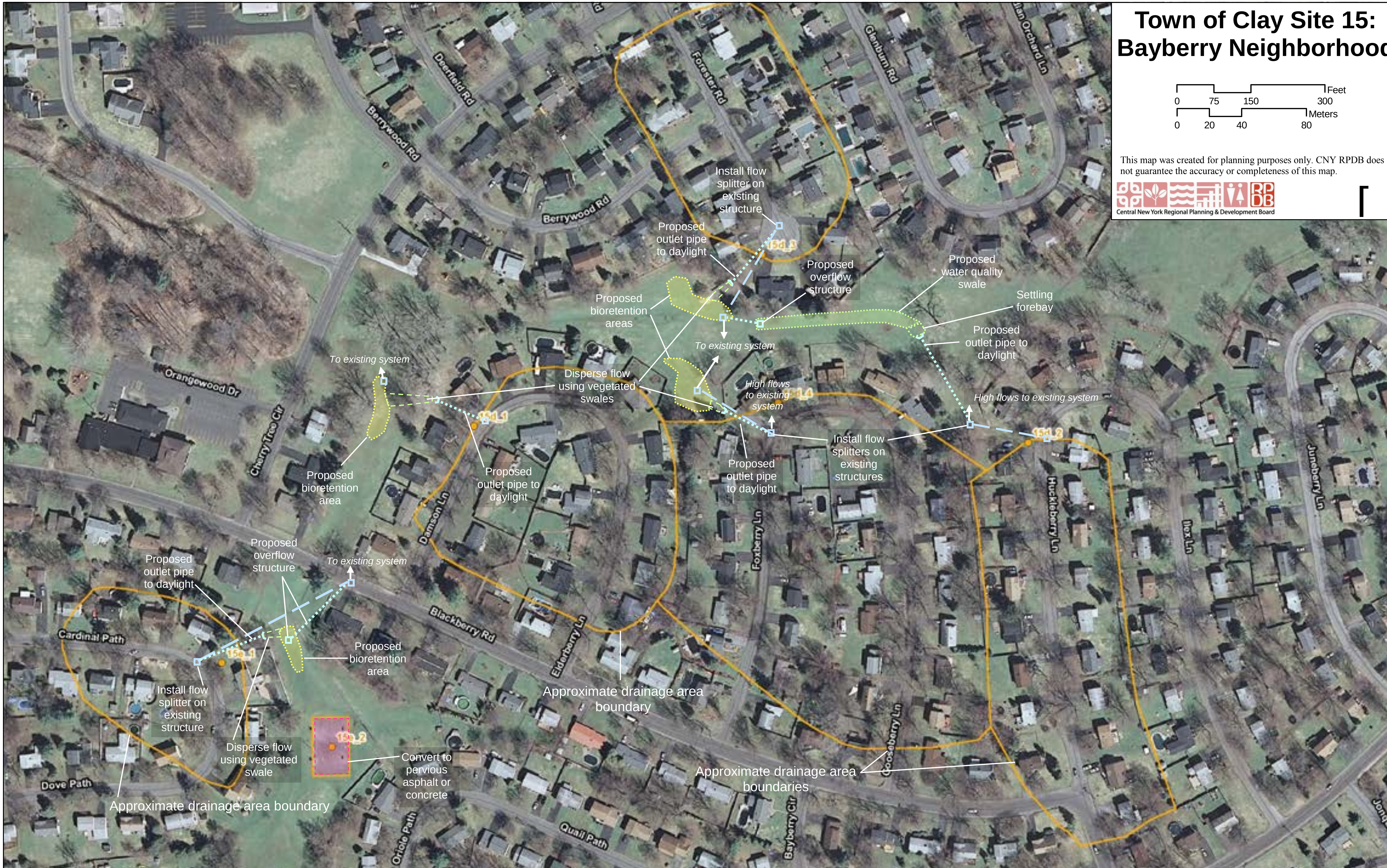
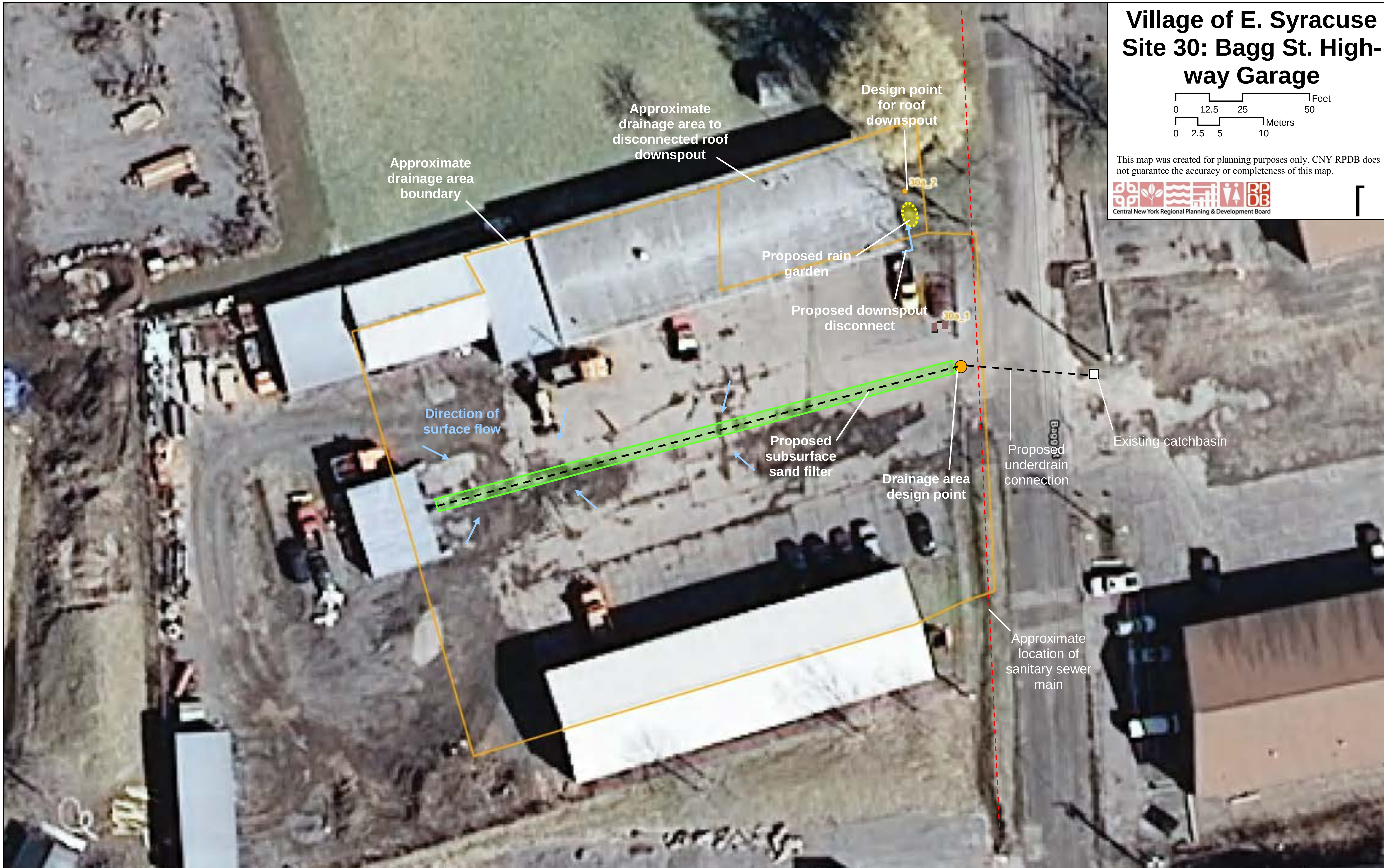
Appendix C

Design concept sketches for Level 3 sites

Town of Clay Site 15: Bayberry Neighborhood



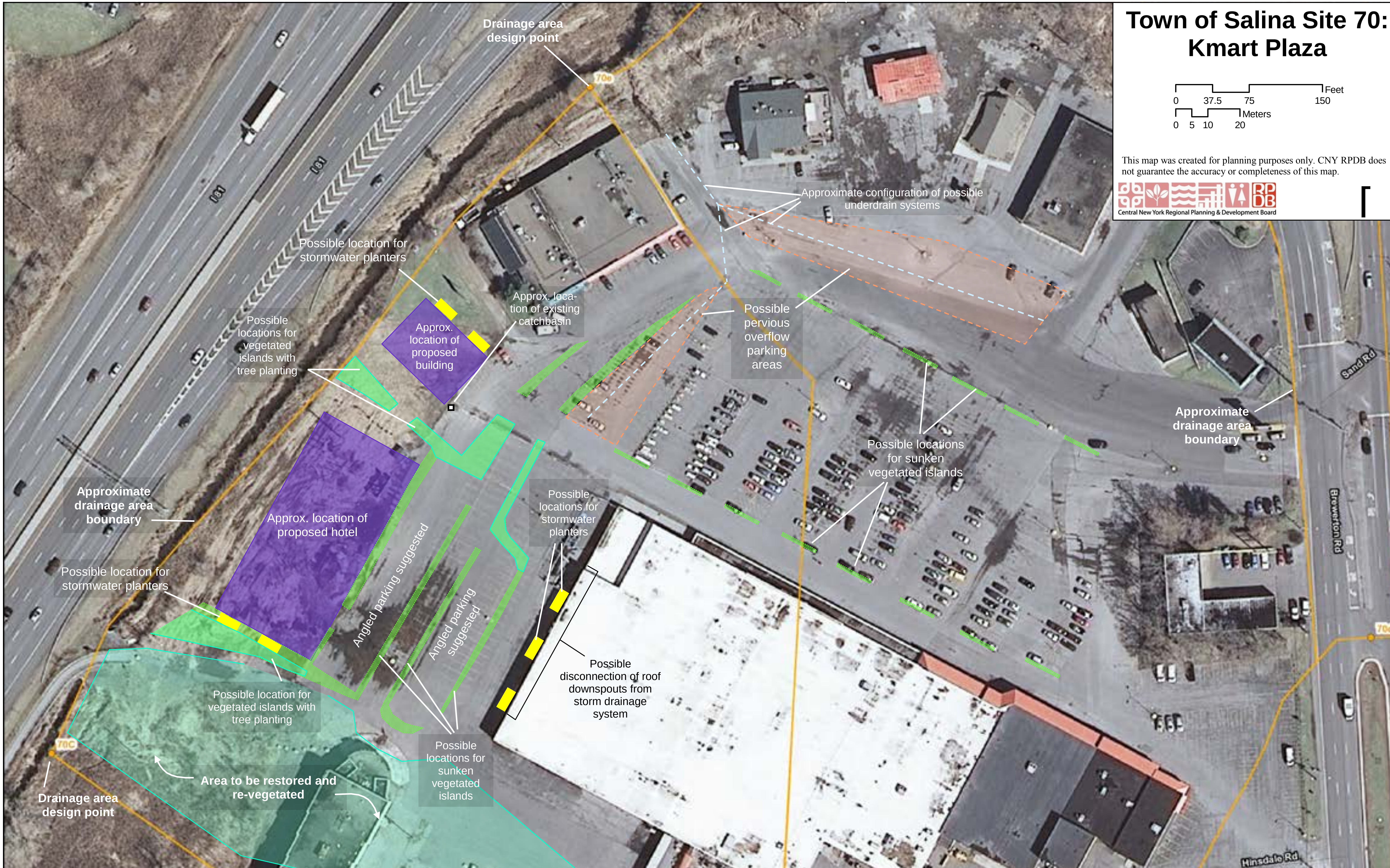
Village of E. Syracuse Site 30: Bagg St. Highway Garage

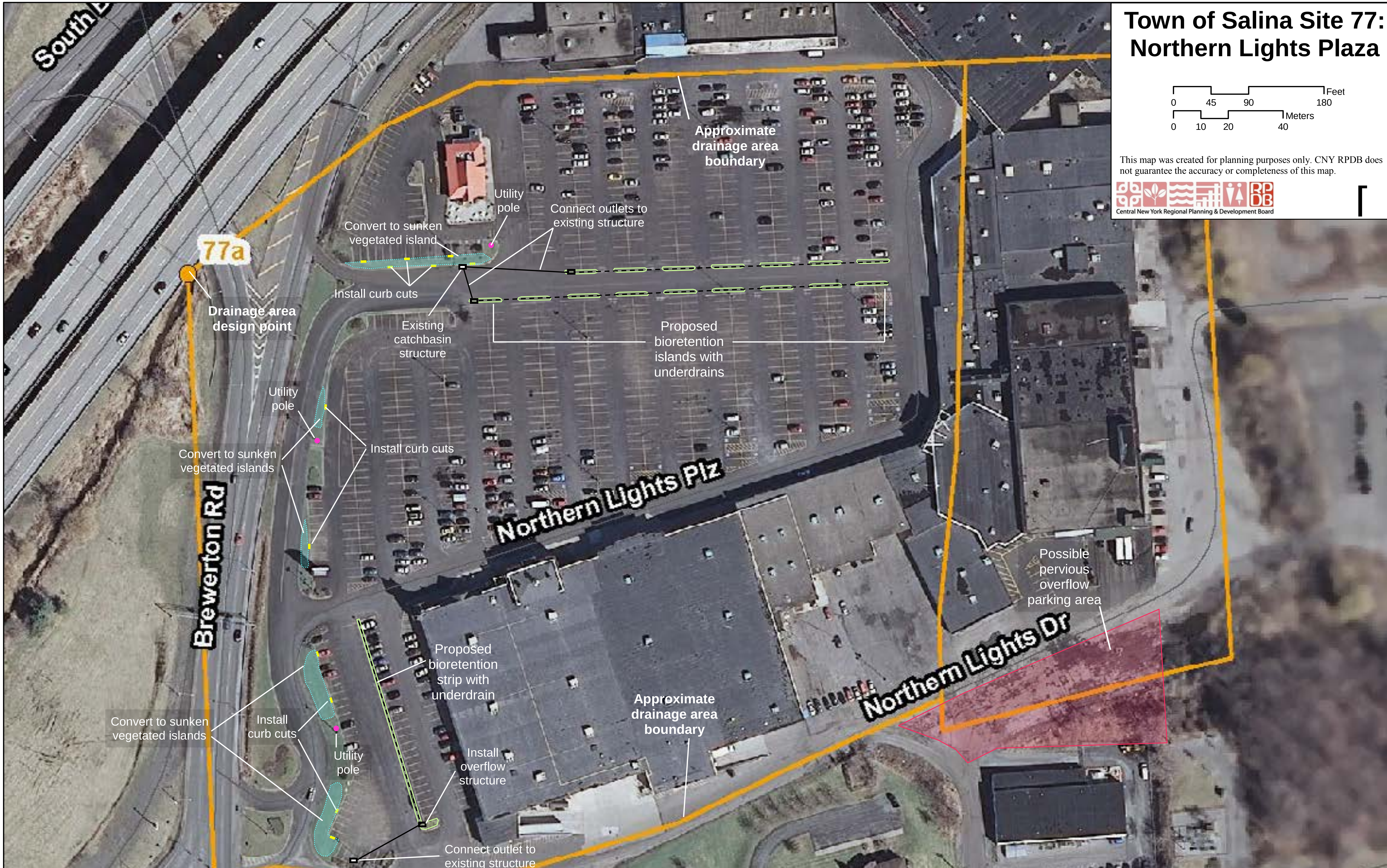


Village of N. Syracuse Site 63: Centerville Pl./ S. Bay Road

Onondaga County Site 94: Onondaga Lake Park Traffic Circle
0 50 100 200 Feet
0 10 20 40 Meters
This map was created for planning purposes only. CNY RPDB does not guarantee the accuracy or completeness of this map.
Central New York Regional Planning & Development Board
Onondaga Lake Pkwy
I 90
Approximate location of buried fiber optics cable
Proposed vegetated swale
Approximate drainage area and design point
94b
Possible locations for sunken vegetated islands
Proposed overflow weir
Proposed vegetated swale
Approximate location of buried fiber optics cable
Approx location of utility service box
Approx location of 6" water main
Proposed overflow structure and outlet pipe
Proposed water quality swales
Proposed underdrains
Approx. location of existing water main
Sewage pump station and force mains
Possible location for pocket wetland
Approx. location of 6" force main
Approximate drainage area and design point
94a
93a
Approximate drainage area and design point

Onondaga County Site 95: Onondaga Lake Park Recreation Trail


Town of Salina Site 70: Kmart Plaza
0 37.5 75 150 Feet
0 5 10 20 Meters
This map was created for planning purposes only. CNY RPDB does not guarantee the accuracy or completeness of this map.
Central New York Regional Planning & Development Board
Drainage area design point
70e
Approximate configuration of possible underdrain systems
Possible location for stormwater planters
Approx. location of existing catchbasin
Possible locations for vegetated islands with tree planting
Approx. location of proposed building
Possible pervious overflow parking areas
Approximate drainage area boundary
Possible locations for sunken vegetated islands
Approximate drainage area boundary
Approx. location of proposed hotel
Angled parking suggested
Angled parking suggested
Possible locations for stormwater planters
Possible location for stormwater planters
Possible disconnection of roof downspouts from storm drainage system
Possible location for vegetated islands with tree planting
Possible locations for sunken vegetated islands
Area to be restored and re-vegetated
Drainage area design point
70c
70d
Sand Rd
Brewerton Rd
Hinsdale Rd
I 81
I 81



Town of Salina Site 77:
Northern Lights Plaza
Feet
0 45 90 180
Meters
0 10 20 40
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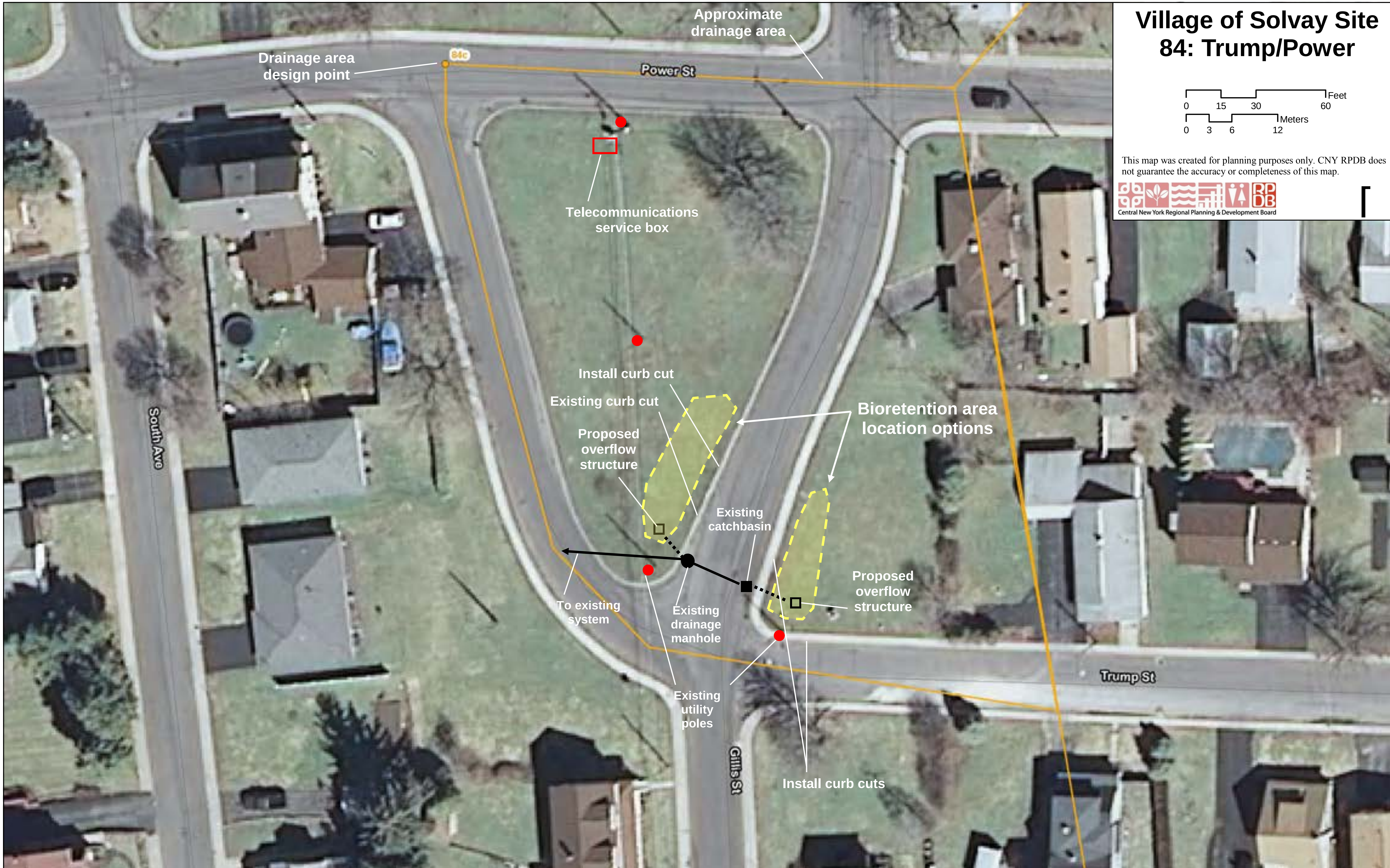
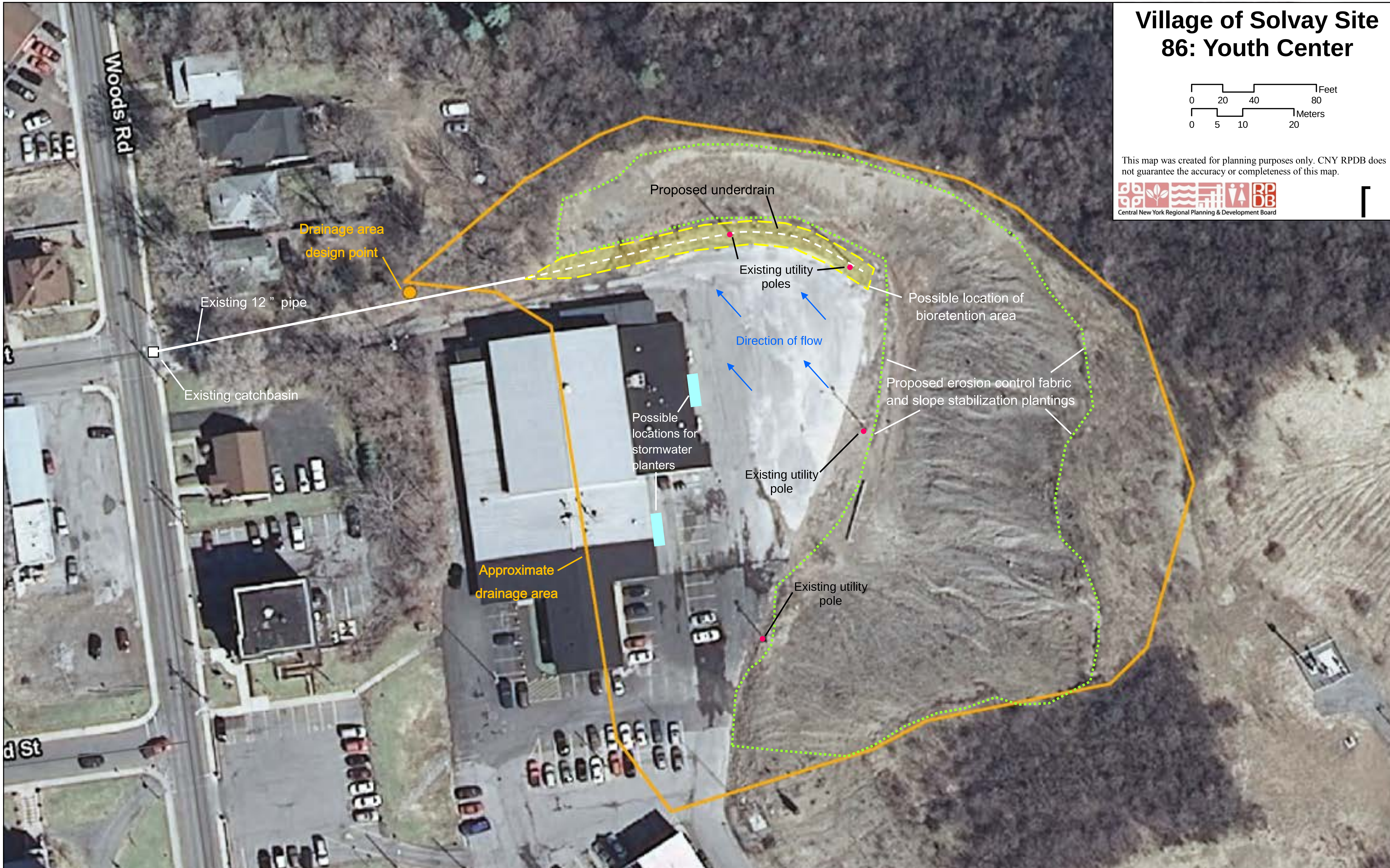
Central New York Regional Planning & Development Board
77a
Drainage area design point
Approximate drainage area boundary
Utility pole
Convert to sunken vegetated island
Connect outlets to existing structure
Install curb cuts
Existing catchbasin structure
Proposed bioretention islands with underdrains
Utility pole
Convert to sunken vegetated islands
Install curb cuts
Northern Lights Plz
Brewerton Rd
Proposed bioretention strip with underdrain
Convert to sunken vegetated islands
Install curb cuts
Utility pole
Install overflow structure
Connect outlet to existing structure
Approximate drainage area boundary
Possible pervious overflow parking area
Northern Lights Dr


Village of Solvay Site 83: Highway Garage
Feet
0 20 40 80
Meters
0 5 10 20
This map was created for planning purposes only. CNY RPDB does not guarantee the accuracy or completeness of this map.
Central New York Regional Planning & Development Board
Drainage area design point
83d
Approximate location of clay tile drain
Proposed structure to connect to tile drain
Approximate location of existing conveyance
Approximate locations of existing water lines
Approximate location of proposed Type O-1 dry swale
Approximate drainage area
Approximate path of flow to wetland
Proposed pretreatment sedimentation chamber
Proposed underdrain
Proposed check dam
Bailey St
Milton Ave
3rd St
Brooks St


Village of Solvay Site 84: Trump/Power
0 15 30 60 Feet
0 3 6 12 Meters
This map was created for planning purposes only. CNY RPDB does not guarantee the accuracy or completeness of this map.
Central New York Regional Planning & Development Board
Drainage area design point
84c
Power St
Approximate drainage area
Telecommunications service box
Install curb cut
Existing curb cut
Proposed overflow structure
Bioretention area location options
Existing catchbasin
To existing system
Existing drainage manhole
Proposed overflow structure
Existing utility poles
Install curb cuts
South Ave
Gillis St
Trump St

Village of Solvay Site 86: Youth Center



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